US010779821B2

(12) **United States Patent**
Harris et al.

(10) **Patent No.: US 10,779,821 B2**
(45) **Date of Patent: Sep. 22, 2020**

(54) **SURGICAL STAPLER ANVILS WITH TISSUE STOP FEATURES CONFIGURED TO AVOID TISSUE PINCH**

(71) Applicant: **Ethicon LLC**, Guaynabo, PR (US)

(72) Inventors: **Jason L. Harris**, Lebanon, OH (US); **Frederick E. Shelton, IV**, Hillsboro, OH (US); **Chester O. Baxter, III**, Loveland, OH (US); **Taylor W. Aronhalt**, Loveland, OH (US)

(73) Assignee: **Ethicon LLC**, Guaynabo, PR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 194 days.

(21) Appl. No.: **16/105,140**

(22) Filed: **Aug. 20, 2018**

(65) **Prior Publication Data**

US 2020/0054325 A1 Feb. 20, 2020

(51) **Int. Cl.**

A61B 17/072	(2006.01)
A61B 17/00	(2006.01)
A61B 17/068	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 17/072*** (2013.01); ***A61B 17/07207*** (2013.01); *A61B 17/00234* (2013.01); *A61B 17/068* (2013.01); *A61B 2017/07214* (2013.01); *A61B 2017/07228* (2013.01); *A61B 2017/07257* (2013.01); *A61B 2017/07271* (2013.01); *A61B 2017/07278* (2013.01)

(58) **Field of Classification Search**

CPC A61B 17/068; A61B 17/072; A61B 17/07207; A61B 17/00234; A61B 17/115; A61B 17/0688; A61B 2017/07214; A61B 2017/00477

USPC 227/19, 175.1, 176.1, 175.2, 180.1; 606/1, 139, 219

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

66,052 A	6/1867	Smith
662,587 A	11/1900	Blake
670,748 A	3/1901	Weddeler
719,487 A	2/1903	Minor
804,229 A	11/1905	Hutchinson
951,393 A	3/1910	Hahn
1,188,721 A	6/1916	Bittner

(Continued)

FOREIGN PATENT DOCUMENTS

AU	2011218702 B2	6/2013
AU	2012200178 B2	7/2013

(Continued)

OTHER PUBLICATIONS

"Biomedical Coatings," Fort Wayne Metals, Research Products Corporation, obtained online at www.fwmetals.com on Jun. 21, 2010 (1 page).

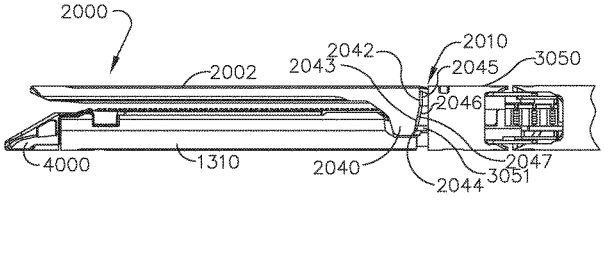
(Continued)

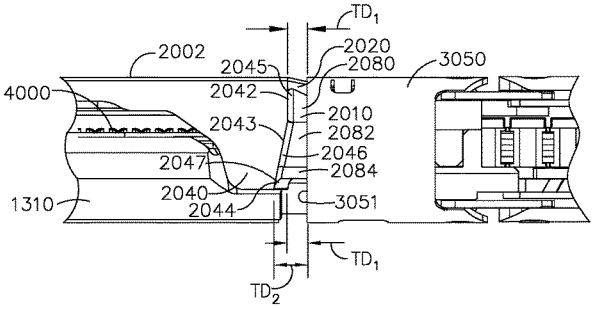
Primary Examiner — Scott A Smith

(57) **ABSTRACT**

Anvils for surgical devices designed to cut and staple tissue. The anvils include tissue stop arrangements for positioning the tissue to be cut and stapled in the device so that the tissue is stapled prior to being cut. The anvils are moved between open and closed positions by a corresponding closure member. The tissue stops and/or closure members are configured to avoid adjacent tissue from being pinched between the closure member and tissue stops when the anvil is in a closed position.

20 Claims, 22 Drawing Sheets





(56) **References Cited**

U.S. PATENT DOCUMENTS

1,306,107 A 6/1919 Elliott
1,314,601 A 9/1919 McCaskey
1,677,337 A 7/1928 Grove
1,794,907 A 3/1931 Kelly
1,849,427 A 3/1932 Hook
1,944,116 A 1/1934 Stratman
1,954,048 A 4/1934 Jeffrey et al.
2,037,727 A 4/1936 La Chapelle
2,132,295 A 10/1938 Hawkins
2,161,632 A 6/1939 Nattenheimer
D120,434 S 5/1940 Gold
2,211,117 A 8/1940 Hess
2,214,870 A 9/1940 West
2,224,882 A 12/1940 Peck
2,318,379 A 5/1943 Davis et al.
2,329,440 A 9/1943 La Place
2,377,581 A 6/1945 Shaffrey
2,406,389 A 8/1946 Royal Lee
2,441,096 A 5/1948 Happe
2,448,741 A 9/1948 Scott et al.
2,450,527 A 10/1948 Smith
2,507,872 A 5/1950 Unsinger
2,526,902 A 10/1950 Rublee
2,527,256 A 10/1950 Jackson
2,578,686 A 12/1951 Fish
2,638,901 A 5/1953 Sugarbaker
2,674,149 A 4/1954 Benson
2,701,489 A 2/1955 Osborn
2,711,461 A 6/1955 Happe
2,742,955 A 4/1956 Dominguez
2,804,848 A 9/1957 O'Farrell et al.
2,808,482 A 10/1957 Zanichkowsky et al.
2,853,074 A 9/1958 Olson
2,887,004 A 5/1959 Stewart
2,957,353 A 10/1960 Lewis
2,959,974 A 11/1960 Emrick
3,032,769 A 5/1962 Palmer
3,060,972 A 10/1962 Sheldon
3,075,062 A 1/1963 Iaccarino
3,078,465 A 2/1963 Bobrov
3,079,606 A 3/1963 Bobrov et al.
3,080,564 A 3/1963 Strekopitov et al.
3,166,072 A 1/1965 Sullivan, Jr.
3,180,236 A 4/1965 Beckett
3,196,869 A 7/1965 Scholl
3,204,731 A 9/1965 Bent et al.
3,266,494 A 8/1966 Brownrigg et al.
3,269,630 A 8/1966 Fleischer
3,269,631 A 8/1966 Takaro
3,275,211 A 9/1966 Hirsch et al.
3,317,103 A 5/1967 Cullen et al.
3,317,105 A 5/1967 Astafjev et al.
3,357,296 A 12/1967 Lefever
3,359,978 A 12/1967 Smith, Jr.
3,377,893 A 4/1968 Shorb
3,480,193 A 11/1969 Ralston
3,490,675 A 1/1970 Green et al.
3,494,533 A 2/1970 Green et al.
3,499,591 A 3/1970 Green
3,503,396 A 3/1970 Pierie et al.
3,509,629 A 5/1970 Kidokoro
3,551,987 A 1/1971 Wilkinson
3,568,675 A 3/1971 Harvey
3,572,159 A 3/1971 Tschanz
3,583,393 A 6/1971 Takahashi
3,589,589 A 6/1971 Akopov
3,598,943 A 8/1971 Barrett
3,608,549 A 9/1971 Merrill
3,618,842 A 11/1971 Bryan
3,638,652 A 2/1972 Kelley
3,640,317 A 2/1972 Panfili
3,643,851 A 2/1972 Green et al.
3,650,453 A 3/1972 Smith, Jr.
3,661,666 A 5/1972 Foster et al.
3,662,939 A 5/1972 Bryan
3,688,966 A 9/1972 Perkins et al.
3,695,646 A 10/1972 Mommsen
3,709,221 A 1/1973 Riely
3,717,294 A 2/1973 Green
3,726,755 A 4/1973 Shannon
3,727,904 A 4/1973 Gabbey
3,734,207 A 5/1973 Fishbein
3,740,994 A 6/1973 De Carlo, Jr.
3,744,495 A 7/1973 Johnson
3,746,002 A 7/1973 Haller
3,747,603 A 7/1973 Adler
3,747,692 A 7/1973 Davidson
3,751,902 A 8/1973 Kingsbury et al.
3,752,161 A 8/1973 Bent
3,799,151 A 3/1974 Fukaumi et al.
3,808,452 A 4/1974 Hutchinson
3,815,476 A 6/1974 Green et al.
3,819,100 A 6/1974 Noiles et al.
3,821,919 A 7/1974 Knohl
3,836,171 A 9/1974 Hayashi et al.
3,837,555 A 9/1974 Green
3,841,474 A 10/1974 Maier
3,851,196 A 11/1974 Hinds
3,863,639 A 2/1975 Kleaveland
3,883,624 A 5/1975 McKenzie et al.
3,885,491 A 5/1975 Curtis
3,892,228 A 7/1975 Mitsui
3,894,174 A 7/1975 Cartun
3,902,247 A 9/1975 Fleer et al.
3,940,844 A 3/1976 Colby et al.
3,944,163 A 3/1976 Hayashi et al.
3,950,686 A 4/1976 Randall
3,952,747 A 4/1976 Kimmell, Jr.
3,955,581 A 5/1976 Spasiano et al.
3,959,879 A 6/1976 Sellers
RE28,932 E 8/1976 Noiles et al.
3,972,734 A 8/1976 King
3,981,051 A 9/1976 Brumlik
4,025,216 A 5/1977 Hives
4,027,746 A 6/1977 Kine
4,034,143 A 7/1977 Sweet
4,038,987 A 8/1977 Komiya
4,054,108 A 10/1977 Gill
4,060,089 A 11/1977 Noiles
4,066,133 A 1/1978 Voss
4,085,337 A 4/1978 Moeller
4,100,820 A 7/1978 Evett
4,106,446 A 8/1978 Yamada et al.
4,106,620 A 8/1978 Brimmer et al.
4,108,211 A 8/1978 Tanaka
4,111,206 A 9/1978 Vishnevsky et al.
4,127,227 A 11/1978 Green
4,129,059 A 12/1978 Van Eck
4,132,146 A 1/1979 Uhlig
4,135,517 A 1/1979 Reale
4,154,122 A 5/1979 Severin
4,169,990 A 10/1979 Lerdman
4,180,285 A 12/1979 Reneau
4,185,701 A 1/1980 Boys
4,190,042 A 2/1980 Sinnreich
4,198,734 A 4/1980 Brumlik
4,198,982 A 4/1980 Fortner et al.
4,207,898 A 6/1980 Becht
4,213,562 A 7/1980 Garrett et al.
4,226,242 A 10/1980 Jarvik
4,239,431 A 12/1980 Davini
4,241,861 A 12/1980 Fleischer
4,244,372 A 1/1981 Kapitanov et al.
4,250,436 A 2/1981 Weissman
4,261,244 A 4/1981 Becht et al.
4,272,002 A 6/1981 Moshofsky
4,272,662 A 6/1981 Simpson
4,274,304 A 6/1981 Curtiss
4,274,398 A 6/1981 Scott, Jr.
4,275,813 A 6/1981 Noiles
4,278,091 A 7/1981 Borzone
4,289,131 A 9/1981 Mueller
4,289,133 A 9/1981 Rothfuss
4,290,542 A 9/1981 Fedotov et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

D261,356 S 10/1981 Robinson
4,293,604 A 10/1981 Campbell
4,296,654 A 10/1981 Mercer
4,296,881 A 10/1981 Lee
4,304,236 A 12/1981 Conta et al.
4,305,539 A 12/1981 Korolkov et al.
4,312,363 A 1/1982 Rothfuss et al.
4,312,685 A 1/1982 Riedl
4,317,451 A 3/1982 Cerwin et al.
4,319,576 A 3/1982 Rothfuss
4,321,002 A 3/1982 Froehlich
4,321,746 A 3/1982 Grinage
4,328,839 A 5/1982 Lyons et al.
4,331,277 A 5/1982 Green
4,340,331 A 7/1982 Savino
4,347,450 A 8/1982 Colligan
4,348,603 A 9/1982 Huber
4,349,028 A 9/1982 Green
4,350,151 A 9/1982 Scott
4,353,371 A 10/1982 Cosman
4,357,940 A 11/1982 Muller
4,361,057 A 11/1982 Kochera
4,366,544 A 12/1982 Shima et al.
4,369,013 A 1/1983 Abildgaard et al.
4,373,147 A 2/1983 Carlson, Jr.
4,376,380 A 3/1983 Burgess
4,379,457 A 4/1983 Gravener et al.
4,380,312 A 4/1983 Landrus
4,382,326 A 5/1983 Rabuse
4,383,634 A 5/1983 Green
4,393,728 A 7/1983 Larson et al.
4,394,613 A 7/1983 Cole
4,396,139 A 8/1983 Hall et al.
4,397,311 A 8/1983 Kanshin et al.
4,402,445 A 9/1983 Green
4,406,621 A 9/1983 Bailey
4,408,692 A 10/1983 Sigel et al.
4,409,057 A 10/1983 Molenda et al.
4,415,112 A 11/1983 Green
4,416,276 A 11/1983 Newton et al.
4,417,890 A 11/1983 Dennehey et al.
4,423,456 A 12/1983 Zaidenweber
4,428,376 A 1/1984 Mericle
4,429,695 A 2/1984 Green
4,430,997 A 2/1984 DiGiovanni et al.
4,434,796 A 3/1984 Karapetian et al.
4,438,659 A 3/1984 Desplats
4,442,964 A 4/1984 Becht
4,448,194 A 5/1984 DiGiovanni et al.
4,451,743 A 5/1984 Suzuki et al.
4,452,376 A 6/1984 Klieman et al.
4,454,887 A 6/1984 Kruger
4,461,305 A 7/1984 Cibley
4,467,805 A 8/1984 Fukuda
4,468,597 A 8/1984 Baumard et al.
4,469,481 A 9/1984 Kobayashi
4,470,414 A 9/1984 Imagawa et al.
4,471,780 A 9/1984 Menges et al.
4,471,781 A 9/1984 Di Giovanni et al.
4,473,077 A 9/1984 Noiles et al.
4,475,679 A 10/1984 Fleury, Jr.
4,478,220 A 10/1984 Di Giovanni et al.
4,480,641 A 11/1984 Failla et al.
4,485,816 A 12/1984 Krumme
4,485,817 A 12/1984 Swiggett
4,486,928 A 12/1984 Tucker et al.
4,488,523 A 12/1984 Shichman
4,489,875 A 12/1984 Crawford et al.
4,493,983 A 1/1985 Taggert
4,494,057 A 1/1985 Hotta
4,499,895 A 2/1985 Takayama
4,500,024 A 2/1985 DiGiovanni et al.
D278,081 S 3/1985 Green
4,503,842 A 3/1985 Takayama
4,505,272 A 3/1985 Utyamyshev et al.
4,505,273 A 3/1985 Braun et al.
4,505,414 A 3/1985 Filipi
4,506,671 A 3/1985 Green
4,512,038 A 4/1985 Alexander et al.
4,520,817 A 6/1985 Green
4,522,327 A 6/1985 Korthoff et al.
4,526,174 A 7/1985 Froehlich
4,527,724 A 7/1985 Chow et al.
4,530,357 A 7/1985 Pawloski et al.
4,530,453 A 7/1985 Green
4,531,522 A 7/1985 Bedi et al.
4,532,927 A 8/1985 Miksza, Jr.
4,540,202 A 9/1985 Amphoux et al.
4,548,202 A 10/1985 Duncan
4,556,058 A 12/1985 Green
4,560,915 A 12/1985 Soultanian
4,565,109 A 1/1986 Tsay
4,565,189 A 1/1986 Mabuchi
4,566,620 A 1/1986 Green et al.
4,569,346 A 2/1986 Poirier
4,569,469 A 2/1986 Mongeon et al.
4,571,213 A 2/1986 Ishimoto
4,573,468 A 3/1986 Conta et al.
4,573,469 A 3/1986 Golden et al.
4,573,622 A 3/1986 Green et al.
4,576,165 A 3/1986 Green et al.
4,576,167 A 3/1986 Noiles
4,580,712 A 4/1986 Green
4,585,153 A 4/1986 Failla et al.
4,586,501 A 5/1986 Claracq
4,586,502 A 5/1986 Bedi et al.
4,589,416 A 5/1986 Green
4,589,582 A 5/1986 Bilotti
4,589,870 A 5/1986 Citrin et al.
4,591,085 A 5/1986 Di Giovanni
RE32,214 E 7/1986 Schramm
4,597,753 A 7/1986 Turley
4,600,037 A 7/1986 Hatten
4,604,786 A 8/1986 Howie, Jr.
4,605,001 A 8/1986 Rothfuss et al.
4,605,004 A 8/1986 Di Giovanni et al.
4,606,343 A 8/1986 Conta et al.
4,607,636 A 8/1986 Kula et al.
4,607,638 A 8/1986 Crainich
4,608,981 A 9/1986 Rothfuss et al.
4,610,250 A 9/1986 Green
4,610,383 A 9/1986 Rothfuss et al.
4,612,933 A 9/1986 Brinkerhoff et al.
D286,180 S 10/1986 Korthoff
D286,442 S 10/1986 Korthoff et al.
4,617,893 A 10/1986 Donner et al.
4,617,914 A 10/1986 Ueda
4,619,262 A 10/1986 Taylor
4,619,391 A 10/1986 Sharkany et al.
D287,278 S 12/1986 Spreckelmeier
4,628,459 A 12/1986 Shinohara et al.
4,628,636 A 12/1986 Folger
4,629,107 A 12/1986 Fedotov et al.
4,632,290 A 12/1986 Green et al.
4,633,861 A 1/1987 Chow et al.
4,633,874 A 1/1987 Chow et al.
4,634,419 A 1/1987 Kreizman et al.
4,635,638 A 1/1987 Weintraub et al.
4,641,076 A 2/1987 Linden
4,642,618 A 2/1987 Johnson et al.
4,643,173 A 2/1987 Bell et al.
4,643,731 A 2/1987 Eckenhoff
4,646,722 A 3/1987 Silverstein et al.
4,646,745 A 3/1987 Noiles
4,652,820 A 3/1987 Maresca
4,654,028 A 3/1987 Suma
4,655,222 A 4/1987 Florez et al.
4,662,555 A 5/1987 Thornton
4,663,874 A 5/1987 Sano et al.
4,664,305 A 5/1987 Blake, III et al.
4,665,916 A 5/1987 Green
4,667,674 A 5/1987 Korthoff et al.
4,669,647 A 6/1987 Storace
4,671,278 A 6/1987 Chin

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,671,280 A 6/1987 Dorband et al.
4,671,445 A 6/1987 Barker et al.
4,672,964 A 6/1987 Dee et al.
4,675,944 A 6/1987 Wells
4,676,245 A 6/1987 Fukuda
4,679,460 A 7/1987 Yoshigai
4,679,719 A 7/1987 Kramer
4,684,051 A 8/1987 Akopov et al.
4,688,555 A 8/1987 Wardle
4,691,703 A 9/1987 Auth et al.
4,693,248 A 9/1987 Failla
4,698,579 A 10/1987 Richter et al.
4,700,703 A 10/1987 Resnick et al.
4,705,038 A 11/1987 Sjostrom et al.
4,708,141 A 11/1987 Inoue et al.
4,709,120 A 11/1987 Pearson
4,715,520 A 12/1987 Roehr, Jr. et al.
4,719,917 A 1/1988 Barrows et al.
4,721,099 A 1/1988 Chikama
4,724,840 A 2/1988 McVay et al.
4,727,308 A 2/1988 Huljak et al.
4,728,020 A 3/1988 Green et al.
4,728,876 A 3/1988 Mongeon et al.
4,729,260 A 3/1988 Dudden
4,730,726 A 3/1988 Holzwarth
4,741,336 A 5/1988 Failla et al.
4,743,214 A 5/1988 Tai-Cheng
4,744,363 A 5/1988 Hasson
4,747,820 A 5/1988 Hornlein et al.
4,750,902 A 6/1988 Wuchinich et al.
4,752,024 A 6/1988 Green et al.
4,754,909 A 7/1988 Barker et al.
4,761,326 A 8/1988 Barnes et al.
4,763,669 A 8/1988 Jaeger
4,767,044 A 8/1988 Green
D297,764 S 9/1988 Hunt et al.
4,773,420 A 9/1988 Green
4,777,780 A 10/1988 Holzwarth
4,781,186 A 11/1988 Simpson et al.
4,784,137 A 11/1988 Kulik et al.
4,787,387 A 11/1988 Burbank, III et al.
4,788,485 A 11/1988 Kawagishi et al.
D298,967 S 12/1988 Hunt
4,790,225 A 12/1988 Moody et al.
4,790,314 A 12/1988 Weaver
4,805,617 A 2/1989 Bedi et al.
4,805,823 A 2/1989 Rothfuss
4,807,628 A 2/1989 Peters et al.
4,809,695 A 3/1989 Gwathmey et al.
4,815,460 A 3/1989 Porat et al.
4,817,643 A 4/1989 Olson
4,817,847 A 4/1989 Redtenbacher et al.
4,819,853 A 4/1989 Green
4,821,939 A 4/1989 Green
4,827,911 A 5/1989 Broadwin et al.
4,828,542 A 5/1989 Hermann
4,828,944 A 5/1989 Yabe et al.
4,830,855 A 5/1989 Stewart
4,832,158 A 5/1989 Farrar et al.
4,833,937 A 5/1989 Nagano
4,834,720 A 5/1989 Blinkhorn
4,838,859 A 6/1989 Strassmann
4,844,068 A 7/1989 Arata et al.
4,848,637 A 7/1989 Pruitt
4,856,078 A 8/1989 Konopka
4,860,644 A 8/1989 Kohl et al.
4,862,891 A 9/1989 Smith
4,863,423 A 9/1989 Wallace
4,865,030 A 9/1989 Polyak
4,868,530 A 9/1989 Ahs
4,869,414 A 9/1989 Green et al.
4,869,415 A 9/1989 Fox
4,873,977 A 10/1989 Avant et al.
4,875,486 A 10/1989 Rapoport et al.
4,880,015 A 11/1989 Nierman
4,890,613 A 1/1990 Golden et al.
4,892,244 A 1/1990 Fox et al.
4,893,622 A 1/1990 Green et al.
4,894,051 A 1/1990 Shiber
4,896,584 A 1/1990 Stoll et al.
4,896,678 A 1/1990 Ogawa
4,900,303 A 2/1990 Lemelson
4,903,697 A 2/1990 Resnick et al.
4,909,789 A 3/1990 Taguchi et al.
4,915,100 A 4/1990 Green
4,919,679 A 4/1990 Averill et al.
4,921,479 A 5/1990 Grayzel
4,925,082 A 5/1990 Kim
4,928,699 A 5/1990 Sasai
4,930,503 A 6/1990 Pruitt
4,930,674 A 6/1990 Barak
4,931,047 A 6/1990 Broadwin et al.
4,931,737 A 6/1990 Hishiki
4,932,960 A 6/1990 Green et al.
4,933,800 A 6/1990 Yang
4,933,843 A 6/1990 Scheller et al.
D309,350 S 7/1990 Sutherland et al.
4,938,408 A 7/1990 Bedi et al.
4,941,623 A 7/1990 Pruitt
4,943,182 A 7/1990 Hoblingre
4,944,443 A 7/1990 Oddsen et al.
4,946,067 A 8/1990 Kelsall
4,948,327 A 8/1990 Crupi, Jr.
4,949,707 A 8/1990 LeVahn et al.
4,951,860 A 8/1990 Peters et al.
4,951,861 A 8/1990 Schulze et al.
4,955,959 A 9/1990 Tompkins et al.
4,957,212 A 9/1990 Duck et al.
4,962,877 A 10/1990 Hervas
4,964,559 A 10/1990 Deniega et al.
4,964,863 A 10/1990 Kanshin et al.
4,965,709 A 10/1990 Ngo
4,973,274 A 11/1990 Hirukawa
4,973,302 A 11/1990 Armour et al.
4,978,049 A 12/1990 Green
4,978,333 A 12/1990 Broadwin et al.
4,979,952 A 12/1990 Kubota et al.
4,984,564 A 1/1991 Yuen
4,986,808 A 1/1991 Broadwin et al.
4,987,049 A 1/1991 Komamura et al.
4,988,334 A 1/1991 Hornlein et al.
4,995,877 A 2/1991 Ams et al.
4,995,959 A 2/1991 Metzner
4,996,975 A 3/1991 Nakamura
5,002,543 A 3/1991 Bradshaw et al.
5,002,553 A 3/1991 Shiber
5,005,754 A 4/1991 Van Overloop
5,009,661 A 4/1991 Michelson
5,012,411 A 4/1991 Policastro et al.
5,014,898 A 5/1991 Heidrich
5,014,899 A 5/1991 Presty et al.
5,015,227 A 5/1991 Broadwin et al.
5,018,515 A 5/1991 Gilman
5,018,657 A 5/1991 Pedlick et al.
5,024,652 A 6/1991 Dumenek et al.
5,024,671 A 6/1991 Tu et al.
5,025,559 A 6/1991 McCullough
5,027,834 A 7/1991 Pruitt
5,030,226 A 7/1991 Green et al.
5,031,814 A 7/1991 Tompkins et al.
5,035,040 A 7/1991 Kerrigan et al.
5,038,109 A 8/1991 Goble et al.
5,038,247 A 8/1991 Kelley et al.
5,040,715 A 8/1991 Green et al.
5,042,707 A 8/1991 Taheri
5,061,269 A 10/1991 Muller
5,062,491 A 11/1991 Takeshima et al.
5,062,563 A 11/1991 Green et al.
5,065,929 A 11/1991 Schulze et al.
5,071,052 A 12/1991 Rodak et al.
5,071,430 A 12/1991 de Salis et al.
5,074,454 A 12/1991 Peters
5,077,506 A 12/1991 Krause
5,079,006 A 1/1992 Urquhart

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,080,556 A 1/1992 Carreno
5,083,695 A 1/1992 Foslien et al.
5,084,057 A 1/1992 Green et al.
5,088,979 A 2/1992 Filipi et al.
5,088,997 A 2/1992 Delahuerga et al.
5,089,606 A 2/1992 Cole et al.
5,094,247 A 3/1992 Hernandez et al.
5,098,004 A 3/1992 Kerrigan
5,098,360 A 3/1992 Hirota
5,100,042 A 3/1992 Gravener et al.
5,100,420 A 3/1992 Green et al.
5,104,025 A 4/1992 Main et al.
5,104,397 A 4/1992 Vasconcelos et al.
5,104,400 A 4/1992 Berguer et al.
5,106,008 A 4/1992 Tompkins et al.
5,108,368 A 4/1992 Hammerslag et al.
5,109,722 A 5/1992 Hufnagle et al.
5,111,987 A 5/1992 Moeinzadeh et al.
5,116,349 A 5/1992 Aranyi
D327,323 S 6/1992 Hunt
5,119,009 A 6/1992 McCaleb et al.
5,122,156 A 6/1992 Granger et al.
5,124,990 A 6/1992 Williamson
5,129,570 A 7/1992 Schulze et al.
5,137,198 A 8/1992 Nobis et al.
5,139,513 A 8/1992 Segato
5,141,144 A 8/1992 Foslien et al.
5,142,932 A 9/1992 Moya et al.
5,155,941 A 10/1992 Takahashi et al.
5,156,315 A 10/1992 Green et al.
5,156,609 A 10/1992 Nakao et al.
5,156,614 A 10/1992 Green et al.
5,158,567 A 10/1992 Green
D330,699 S 11/1992 Gill
5,163,598 A 11/1992 Peters et al.
5,168,605 A 12/1992 Bartlett
5,170,925 A 12/1992 Madden et al.
5,171,247 A 12/1992 Hughett et al.
5,171,249 A 12/1992 Stefanchik et al.
5,171,253 A 12/1992 Klieman
5,173,053 A 12/1992 Swanson et al.
5,173,133 A 12/1992 Morin et al.
5,176,677 A 1/1993 Wuchinich
5,176,688 A 1/1993 Narayan et al.
5,187,422 A 2/1993 Izenbaard et al.
5,188,102 A 2/1993 Idemoto et al.
5,188,111 A 2/1993 Yates et al.
5,190,517 A 3/1993 Zieve et al.
5,190,544 A 3/1993 Chapman et al.
5,190,560 A 3/1993 Woods et al.
5,190,657 A 3/1993 Heagle et al.
5,192,288 A 3/1993 Thompson et al.
5,193,731 A 3/1993 Aranyi
5,195,505 A 3/1993 Josefsen
5,195,968 A 3/1993 Lundquist et al.
5,197,648 A 3/1993 Gingold
5,197,649 A 3/1993 Bessler et al.
5,197,966 A 3/1993 Sommerkamp
5,197,970 A 3/1993 Green et al.
5,200,280 A 4/1993 Karasa
5,201,750 A 4/1993 Hocherl et al.
5,205,459 A 4/1993 Brinkerhoff et al.
5,207,672 A 5/1993 Roth et al.
5,207,697 A 5/1993 Carusillo et al.
5,209,747 A 5/1993 Knoepfler
5,209,756 A 5/1993 Seedhom et al.
5,211,649 A 5/1993 Kohler et al.
5,211,655 A 5/1993 Hasson
5,217,457 A 6/1993 Delahuerga et al.
5,217,478 A 6/1993 Rexroth
5,219,111 A 6/1993 Bilotti et al.
5,220,269 A 6/1993 Chen et al.
5,221,036 A 6/1993 Takase
5,221,281 A 6/1993 Klicek
5,222,945 A 6/1993 Basnight
5,222,963 A 6/1993 Brinkerhoff et al.
5,222,975 A 6/1993 Crainich
5,222,976 A 6/1993 Yoon
5,223,675 A 6/1993 Taft
D338,729 S 8/1993 Sprecklemeier et al.
5,234,447 A 8/1993 Kaster et al.
5,236,269 A 8/1993 Handy
5,236,424 A 8/1993 Imran
5,236,440 A 8/1993 Hlavacek
5,239,981 A 8/1993 Anapliotis
5,240,163 A 8/1993 Stein et al.
5,242,456 A 9/1993 Nash et al.
5,242,457 A 9/1993 Akopov et al.
5,244,462 A 9/1993 Delahuerga et al.
5,246,156 A 9/1993 Rothfuss et al.
5,246,443 A 9/1993 Mai
5,253,793 A 10/1993 Green et al.
5,258,007 A 11/1993 Spetzler et al.
5,258,008 A 11/1993 Wilk
5,258,009 A 11/1993 Conners
5,258,010 A 11/1993 Green et al.
5,258,012 A 11/1993 Luscombe et al.
5,259,366 A 11/1993 Reydel et al.
5,259,835 A 11/1993 Clark et al.
5,260,637 A 11/1993 Pizzi
5,261,135 A 11/1993 Mitchell
5,261,877 A 11/1993 Fine et al.
5,261,922 A 11/1993 Hood
5,263,629 A 11/1993 Trumbull et al.
5,263,937 A 11/1993 Shipp
5,263,973 A 11/1993 Cook
5,264,218 A 11/1993 Rogozinski
5,268,622 A 12/1993 Philipp
5,271,543 A 12/1993 Grant et al.
5,271,544 A 12/1993 Fox et al.
RE34,519 E 1/1994 Fox et al.
5,275,322 A 1/1994 Brinkerhoff et al.
5,275,323 A 1/1994 Schulze et al.
5,275,608 A 1/1994 Forman et al.
5,279,416 A 1/1994 Malec et al.
5,281,216 A 1/1994 Klicek
5,282,806 A 2/1994 Haber et al.
5,282,829 A 2/1994 Hermes
5,284,128 A 2/1994 Hart
5,285,381 A 2/1994 Iskarous et al.
5,285,945 A 2/1994 Brinkerhoff et al.
5,286,253 A 2/1994 Fucci
5,289,963 A 3/1994 McGarry et al.
5,290,271 A 3/1994 Jernberg
5,290,310 A 3/1994 Makower et al.
5,292,053 A 3/1994 Bilotti et al.
5,293,024 A 3/1994 Sugahara et al.
5,297,714 A 3/1994 Kramer
5,304,204 A 4/1994 Bregen
D347,474 S 5/1994 Olson
5,307,976 A 5/1994 Olson et al.
5,308,576 A 5/1994 Green et al.
5,309,387 A 5/1994 Mori et al.
5,309,927 A 5/1994 Welch
5,312,023 A 5/1994 Green et al.
5,312,024 A 5/1994 Grant et al.
5,312,329 A 5/1994 Beaty et al.
5,313,935 A 5/1994 Kortenbach et al.
5,313,967 A 5/1994 Lieber et al.
5,314,424 A 5/1994 Nicholas
5,314,445 A 5/1994 Heidmueller Degwitz et al.
5,314,466 A 5/1994 Stern et al.
5,318,221 A 6/1994 Green et al.
5,320,627 A 6/1994 Sorensen et al.
D348,930 S 7/1994 Olson
5,326,013 A 7/1994 Green et al.
5,329,923 A 7/1994 Lundquist
5,330,487 A 7/1994 Thornton et al.
5,330,502 A 7/1994 Hassler et al.
5,331,971 A 7/1994 Bales et al.
5,332,142 A 7/1994 Robinson et al.
5,333,422 A 8/1994 Warren et al.
5,333,772 A 8/1994 Rothfuss et al.
5,333,773 A 8/1994 Main et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,334,183 A 8/1994 Wuchinich
5,336,130 A 8/1994 Ray
5,336,229 A 8/1994 Noda
5,336,232 A 8/1994 Green et al.
5,339,799 A 8/1994 Kami et al.
5,341,724 A 8/1994 Vatel
5,341,807 A 8/1994 Nardella
5,341,810 A 8/1994 Dardel
5,342,380 A 8/1994 Hood
5,342,381 A 8/1994 Tidemand
5,342,385 A 8/1994 Norelli et al.
5,342,395 A 8/1994 Jarrett et al.
5,342,396 A 8/1994 Cook
5,343,382 A 8/1994 Hale et al.
5,343,391 A 8/1994 Mushabac
5,344,059 A 9/1994 Green et al.
5,344,060 A 9/1994 Gravener et al.
5,344,454 A 9/1994 Clarke et al.
5,346,504 A 9/1994 Ortiz et al.
5,348,259 A 9/1994 Blanco et al.
5,350,355 A 9/1994 Sklar
5,350,388 A 9/1994 Epstein
5,350,391 A 9/1994 Iacovelli
5,350,400 A 9/1994 Esposito et al.
5,352,229 A 10/1994 Goble et al.
5,352,235 A 10/1994 Koros et al.
5,352,238 A 10/1994 Green et al.
5,354,250 A 10/1994 Christensen
5,354,303 A 10/1994 Spaeth et al.
5,356,006 A 10/1994 Alpern et al.
5,356,064 A 10/1994 Green et al.
5,358,506 A 10/1994 Green et al.
5,358,510 A 10/1994 Luscombe et al.
5,359,231 A 10/1994 Flowers et al.
D352,780 S 11/1994 Glaeser et al.
5,359,993 A 11/1994 Slater et al.
5,360,305 A 11/1994 Kerrigan
5,360,428 A 11/1994 Hutchinson, Jr.
5,361,902 A 11/1994 Abidin et al.
5,364,001 A 11/1994 Bryan
5,364,002 A 11/1994 Green et al.
5,364,003 A 11/1994 Williamson, IV
5,366,133 A 11/1994 Geiste
5,366,134 A 11/1994 Green et al.
5,366,479 A 11/1994 McGarry et al.
5,368,015 A 11/1994 Wilk
5,368,592 A 11/1994 Stern et al.
5,369,565 A 11/1994 Chen et al.
5,370,645 A 12/1994 Klicek et al.
5,372,124 A 12/1994 Takayama et al.
5,372,596 A 12/1994 Klicek et al.
5,372,602 A 12/1994 Burke
5,374,277 A 12/1994 Hassler
5,375,588 A 12/1994 Yoon
5,376,095 A 12/1994 Ortiz
5,379,933 A 1/1995 Green et al.
5,381,649 A 1/1995 Webb
5,381,782 A 1/1995 DeLaRama et al.
5,381,943 A 1/1995 Allen et al.
5,382,247 A 1/1995 Cimino et al.
5,383,460 A 1/1995 Jang et al.
5,383,880 A 1/1995 Hooven
5,383,881 A 1/1995 Green et al.
5,383,882 A 1/1995 Buess et al.
5,383,888 A 1/1995 Zvenyatsky et al.
5,383,895 A 1/1995 Holmes et al.
5,388,568 A 2/1995 van der Heide
5,389,098 A 2/1995 Tsuruta et al.
5,389,102 A 2/1995 Green et al.
5,389,104 A 2/1995 Hahnen et al.
5,391,180 A 2/1995 Tovey et al.
5,392,979 A 2/1995 Green et al.
5,395,030 A 3/1995 Kuramoto et al.
5,395,033 A 3/1995 Byrne et al.
5,395,034 A 3/1995 Allen et al.
5,395,312 A 3/1995 Desai
5,395,384 A 3/1995 Duthoit et al.
5,397,046 A 3/1995 Savage et al.
5,397,324 A 3/1995 Carroll et al.
5,400,267 A 3/1995 Denen et al.
5,403,276 A 4/1995 Schechter et al.
5,403,312 A 4/1995 Yates et al.
5,404,106 A 4/1995 Matsuda
5,404,870 A 4/1995 Brinkerhoff et al.
5,404,960 A 4/1995 Wada et al.
5,405,072 A 4/1995 Zlock et al.
5,405,073 A 4/1995 Porter
5,405,344 A 4/1995 Williamson et al.
5,405,360 A 4/1995 Tovey
5,407,293 A 4/1995 Crainich
5,408,409 A 4/1995 Glassman et al.
5,409,498 A 4/1995 Braddock et al.
5,409,703 A 4/1995 McAnalley et al.
D357,981 S 5/1995 Green et al.
5,411,481 A 5/1995 Allen et al.
5,411,508 A 5/1995 Bessler et al.
5,413,107 A 5/1995 Oakley et al.
5,413,267 A 5/1995 Solyntjes et al.
5,413,268 A 5/1995 Green et al.
5,413,272 A 5/1995 Green et al.
5,413,573 A 5/1995 Koivukangas
5,415,334 A 5/1995 Williamson et al.
5,415,335 A 5/1995 Knodell, Jr.
5,417,203 A 5/1995 Tovey et al.
5,417,361 A 5/1995 Williamson, IV
5,419,766 A 5/1995 Chang et al.
5,421,829 A 6/1995 Olichney et al.
5,422,567 A 6/1995 Matsunaga
5,423,471 A 6/1995 Mastri et al.
5,423,809 A 6/1995 Klicek
5,423,835 A 6/1995 Green et al.
5,425,745 A 6/1995 Green et al.
5,427,298 A 6/1995 Tegtmeier
5,431,322 A 7/1995 Green et al.
5,431,323 A 7/1995 Smith et al.
5,431,654 A 7/1995 Nic
5,431,668 A 7/1995 Burbank, III et al.
5,433,721 A 7/1995 Hooven et al.
5,437,681 A 8/1995 Meade et al.
5,438,302 A 8/1995 Goble
5,438,997 A 8/1995 Sieben et al.
5,439,155 A 8/1995 Viola
5,439,156 A 8/1995 Grant et al.
5,439,479 A 8/1995 Shichman et al.
5,441,191 A 8/1995 Linden
5,441,193 A 8/1995 Gravener
5,441,483 A 8/1995 Avitall
5,441,494 A 8/1995 Ortiz
5,443,197 A 8/1995 Malis et al.
5,443,463 A 8/1995 Stern et al.
5,444,113 A 8/1995 Sinclair et al.
5,445,155 A 8/1995 Sieben
5,445,304 A 8/1995 Plyley et al.
5,445,604 A 8/1995 Lang
5,445,644 A 8/1995 Pietrafitta et al.
5,446,646 A 8/1995 Miyazaki
5,447,265 A 9/1995 Vidal et al.
5,447,417 A 9/1995 Kuhl et al.
5,447,513 A 9/1995 Davison et al.
5,449,355 A 9/1995 Rhum et al.
5,449,365 A 9/1995 Green et al.
5,449,370 A 9/1995 Vaitekunas
5,452,836 A 9/1995 Huitema et al.
5,452,837 A 9/1995 Williamson, IV et al.
5,454,378 A 10/1995 Palmer et al.
5,454,822 A 10/1995 Schob et al.
5,454,827 A 10/1995 Aust et al.
5,456,401 A 10/1995 Green et al.
5,456,917 A 10/1995 Wise et al.
5,458,279 A 10/1995 Plyley
5,458,579 A 10/1995 Chodorow et al.
5,462,215 A 10/1995 Viola et al.
5,464,013 A 11/1995 Lemelson
5,464,144 A 11/1995 Guy et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,464,300 A 11/1995 Crainich
5,465,819 A 11/1995 Weilant et al.
5,465,894 A 11/1995 Clark et al.
5,465,895 A 11/1995 Knodel et al.
5,465,896 A 11/1995 Allen et al.
5,466,020 A 11/1995 Page et al.
5,467,911 A 11/1995 Tsuruta et al.
5,468,253 A 11/1995 Bezwada et al.
5,470,006 A 11/1995 Rodak
5,470,007 A 11/1995 Plyley et al.
5,470,008 A 11/1995 Rodak
5,470,009 A 11/1995 Rodak
5,470,010 A 11/1995 Rothfuss et al.
5,471,129 A 11/1995 Mann
5,472,132 A 12/1995 Savage et al.
5,472,442 A 12/1995 Klicek
5,473,204 A 12/1995 Temple
5,474,057 A 12/1995 Makower et al.
5,474,223 A 12/1995 Viola et al.
5,474,566 A 12/1995 Alesi et al.
5,474,570 A 12/1995 Kockerling et al.
5,476,206 A 12/1995 Green et al.
5,476,479 A 12/1995 Green et al.
5,476,481 A 12/1995 Schondorf
5,478,003 A 12/1995 Green et al.
5,478,354 A 12/1995 Tovey et al.
5,480,089 A 1/1996 Blewett
5,480,409 A 1/1996 Riza
5,482,197 A 1/1996 Green et al.
5,483,952 A 1/1996 Aranyi
5,484,095 A 1/1996 Green et al.
5,484,398 A 1/1996 Stoddard
5,484,451 A 1/1996 Akopov et al.
5,485,947 A 1/1996 Olson et al.
5,485,952 A 1/1996 Fontayne
5,487,499 A 1/1996 Sorrentino et al.
5,487,500 A 1/1996 Knodel et al.
5,489,058 A 2/1996 Plyley et al.
5,489,256 A 2/1996 Adair
5,489,290 A 2/1996 Furnish
5,490,819 A 2/1996 Nicholas et al.
5,492,671 A 2/1996 Krafft
5,496,312 A 3/1996 Klicek
5,496,317 A 3/1996 Goble et al.
5,497,933 A 3/1996 DeFonzo et al.
5,498,164 A 3/1996 Ward et al.
5,498,838 A 3/1996 Furman
5,501,654 A 3/1996 Failla et al.
5,503,320 A 4/1996 Webster et al.
5,503,635 A 4/1996 Sauer et al.
5,503,638 A 4/1996 Cooper et al.
5,505,363 A 4/1996 Green et al.
5,507,425 A 4/1996 Ziglioli
5,507,426 A 4/1996 Young et al.
5,509,596 A 4/1996 Green et al.
5,509,916 A 4/1996 Taylor
5,511,564 A 4/1996 Wilk
5,514,129 A 5/1996 Smith
5,514,149 A 5/1996 Green et al.
5,514,157 A 5/1996 Nicholas et al.
5,518,163 A 5/1996 Hooven
5,518,164 A 5/1996 Hooven
5,520,609 A 5/1996 Moll et al.
5,520,634 A 5/1996 Fox et al.
5,520,678 A 5/1996 Heckele et al.
5,520,700 A 5/1996 Beyar et al.
5,522,817 A 6/1996 Sander et al.
5,522,831 A 6/1996 Sleister et al.
5,527,264 A 6/1996 Moll et al.
5,527,320 A 6/1996 Carruthers et al.
5,529,235 A 6/1996 Boiarski et al.
D372,086 S 7/1996 Grasso et al.
5,531,305 A 7/1996 Roberts et al.
5,531,744 A 7/1996 Nardella et al.
5,531,856 A 7/1996 Moll et al.
5,533,521 A 7/1996 Granger
5,533,581 A 7/1996 Barth et al.
5,533,661 A 7/1996 Main et al.
5,535,934 A 7/1996 Boiarski et al.
5,535,935 A 7/1996 Vidal et al.
5,535,937 A 7/1996 Boiarski et al.
5,540,375 A 7/1996 Bolanos et al.
5,540,705 A 7/1996 Meade et al.
5,541,376 A 7/1996 Ladtkow et al.
5,541,489 A 7/1996 Dunstan
5,542,594 A 8/1996 McKean et al.
5,542,949 A 8/1996 Yoon
5,543,119 A 8/1996 Sutter et al.
5,543,695 A 8/1996 Culp et al.
5,544,802 A 8/1996 Crainich
5,547,117 A 8/1996 Hamblin et al.
5,549,583 A 8/1996 Sanford et al.
5,549,621 A 8/1996 Bessler et al.
5,549,627 A 8/1996 Kieturakis
5,549,628 A 8/1996 Cooper et al.
5,549,637 A 8/1996 Crainich
5,551,622 A 9/1996 Yoon
5,553,624 A 9/1996 Francese et al.
5,553,675 A 9/1996 Pitzen et al.
5,553,765 A 9/1996 Knodel et al.
5,554,148 A 9/1996 Aebischer et al.
5,554,169 A 9/1996 Green et al.
5,556,020 A 9/1996 Hou
5,556,416 A 9/1996 Clark et al.
5,558,533 A 9/1996 Hashizawa et al.
5,558,665 A 9/1996 Kieturakis
5,558,671 A 9/1996 Yates
5,560,530 A 10/1996 Bolanos et al.
5,560,532 A 10/1996 DeFonzo et al.
5,561,881 A 10/1996 Klinger et al.
5,562,239 A 10/1996 Boiarski et al.
5,562,241 A 10/1996 Knodel et al.
5,562,682 A 10/1996 Oberlin et al.
5,562,690 A 10/1996 Green et al.
5,562,701 A 10/1996 Huitema et al.
5,562,702 A 10/1996 Huitema et al.
5,563,481 A 10/1996 Krause
5,564,615 A 10/1996 Bishop et al.
5,569,161 A 10/1996 Ebling et al.
5,569,270 A 10/1996 Weng
5,569,284 A 10/1996 Young et al.
5,571,090 A 11/1996 Sherts
5,571,100 A 11/1996 Goble et al.
5,571,116 A 11/1996 Bolanos et al.
5,571,285 A 11/1996 Chow et al.
5,571,488 A 11/1996 Beerstecher et al.
5,573,169 A 11/1996 Green et al.
5,573,543 A 11/1996 Akopov et al.
5,574,431 A 11/1996 McKeown et al.
5,575,054 A 11/1996 Klinzing et al.
5,575,789 A 11/1996 Bell et al.
5,575,799 A 11/1996 Bolanos et al.
5,575,803 A 11/1996 Cooper et al.
5,575,805 A 11/1996 Li
5,577,654 A 11/1996 Bishop
5,578,052 A 11/1996 Koros et al.
5,579,978 A 12/1996 Green et al.
5,580,067 A 12/1996 Hamblin et al.
5,582,611 A 12/1996 Tsuruta et al.
5,582,617 A 12/1996 Klieman et al.
5,582,907 A 12/1996 Pall
5,583,114 A 12/1996 Barrows et al.
5,584,425 A 12/1996 Savage et al.
5,586,711 A 12/1996 Plyley et al.
5,588,579 A 12/1996 Schnut et al.
5,588,580 A 12/1996 Paul et al.
5,588,581 A 12/1996 Conlon et al.
5,591,170 A 1/1997 Spievack et al.
5,591,187 A 1/1997 Dekel
5,597,107 A 1/1997 Knodel et al.
5,599,151 A 2/1997 Daum et al.
5,599,279 A 2/1997 Slotman et al.
5,599,344 A 2/1997 Paterson
5,599,350 A 2/1997 Schulze et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,599,852 A 2/1997 Scopelianos et al.
5,601,224 A 2/1997 Bishop et al.
5,601,573 A 2/1997 Fogelberg et al.
5,601,604 A 2/1997 Vincent
5,602,449 A 2/1997 Krause et al.
5,603,443 A 2/1997 Clark et al.
5,605,272 A 2/1997 Witt et al.
5,605,273 A 2/1997 Hamblin et al.
5,607,094 A 3/1997 Clark et al.
5,607,095 A 3/1997 Smith et al.
5,607,433 A 3/1997 Polla et al.
5,607,450 A 3/1997 Zvenyatsky et al.
5,607,474 A 3/1997 Athanasiou et al.
5,609,285 A 3/1997 Grant et al.
5,609,601 A 3/1997 Kolesa et al.
5,611,709 A 3/1997 McAnulty
5,613,499 A 3/1997 Palmer et al.
5,613,937 A 3/1997 Garrison et al.
5,613,966 A 3/1997 Makower et al.
5,614,887 A 3/1997 Buchbinder
5,615,820 A 4/1997 Viola
5,618,294 A 4/1997 Aust et al.
5,618,303 A 4/1997 Marlow et al.
5,618,307 A 4/1997 Donlon et al.
5,619,992 A 4/1997 Guthrie et al.
5,620,289 A 4/1997 Curry
5,620,326 A 4/1997 Younker
5,620,452 A 4/1997 Yoon
5,624,398 A 4/1997 Smith et al.
5,624,452 A 4/1997 Yates
5,626,587 A 5/1997 Bishop et al.
5,626,595 A 5/1997 Sklar et al.
5,628,446 A 5/1997 Geiste et al.
5,628,743 A 5/1997 Cimino
5,628,745 A 5/1997 Bek
5,630,539 A 5/1997 Plyley et al.
5,630,540 A 5/1997 Blewett
5,630,541 A 5/1997 Williamson, IV et al.
5,630,782 A 5/1997 Adair
5,632,432 A 5/1997 Schulze et al.
5,632,433 A 5/1997 Grant et al.
5,633,374 A 5/1997 Humphrey et al.
5,634,584 A 6/1997 Okorocha et al.
5,636,779 A 6/1997 Palmer
5,636,780 A 6/1997 Green et al.
5,638,582 A 6/1997 Klatt et al.
5,639,008 A 6/1997 Gallagher et al.
D381,077 S 7/1997 Hunt
5,643,291 A 7/1997 Pier et al.
5,643,293 A 7/1997 Kogasaka et al.
5,643,294 A 7/1997 Tovey et al.
5,643,319 A 7/1997 Green et al.
5,645,209 A 7/1997 Green et al.
5,647,526 A 7/1997 Green et al.
5,647,869 A 7/1997 Goble et al.
5,649,937 A 7/1997 Bito et al.
5,649,956 A 7/1997 Jensen et al.
5,651,491 A 7/1997 Heaton et al.
5,651,762 A 7/1997 Bridges
5,651,821 A 7/1997 Uchida
5,653,373 A 8/1997 Green et al.
5,653,374 A 8/1997 Young et al.
5,653,677 A 8/1997 Okada et al.
5,653,721 A 8/1997 Knodel et al.
5,653,748 A 8/1997 Strecker
5,655,698 A 8/1997 Yoon
5,657,417 A 8/1997 Di Troia
5,657,429 A 8/1997 Wang et al.
5,657,921 A 8/1997 Young et al.
5,658,238 A 8/1997 Suzuki et al.
5,658,281 A 8/1997 Heard
5,658,298 A 8/1997 Vincent et al.
5,658,300 A 8/1997 Bito et al.
5,658,307 A 8/1997 Exconde
5,662,258 A 9/1997 Knodel et al.
5,662,260 A 9/1997 Yoon
5,662,662 A 9/1997 Bishop et al.
5,662,667 A 9/1997 Knodel
5,665,085 A 9/1997 Nardella
5,667,517 A 9/1997 Hooven
5,667,526 A 9/1997 Levin
5,667,527 A 9/1997 Cook
5,669,544 A 9/1997 Schulze et al.
5,669,904 A 9/1997 Platt, Jr. et al.
5,669,907 A 9/1997 Platt, Jr. et al.
5,669,918 A 9/1997 Balazs et al.
5,673,840 A 10/1997 Schulze et al.
5,673,841 A 10/1997 Schulze et al.
5,673,842 A 10/1997 Bittner et al.
5,674,286 A 10/1997 D'Alessio et al.
5,678,748 A 10/1997 Plyley et al.
5,680,981 A 10/1997 Mililli et al.
5,680,982 A 10/1997 Schulze et al.
5,680,983 A 10/1997 Plyley et al.
5,681,341 A 10/1997 Lunsford et al.
5,683,349 A 11/1997 Makower et al.
5,685,474 A 11/1997 Seeber
5,686,090 A 11/1997 Schilder et al.
5,688,270 A 11/1997 Yates et al.
5,690,269 A 11/1997 Bolanos et al.
5,692,668 A 12/1997 Schulze et al.
5,693,020 A 12/1997 Rauh
5,693,042 A 12/1997 Boiarski et al.
5,693,051 A 12/1997 Schulze et al.
5,695,494 A 12/1997 Becker
5,695,502 A 12/1997 Pier et al.
5,695,504 A 12/1997 Gifford, III et al.
5,695,524 A 12/1997 Kelley et al.
5,697,542 A 12/1997 Knodel et al.
5,697,543 A 12/1997 Burdorff
5,697,909 A 12/1997 Eggers et al.
5,697,943 A 12/1997 Sauer et al.
5,700,270 A 12/1997 Peyser et al.
5,700,276 A 12/1997 Benecke
5,702,387 A 12/1997 Arts et al.
5,702,408 A 12/1997 Wales et al.
5,702,409 A 12/1997 Rayburn et al.
5,704,087 A 1/1998 Strub
5,704,534 A 1/1998 Huitema et al.
5,706,997 A 1/1998 Green et al.
5,706,998 A 1/1998 Plyley et al.
5,707,392 A 1/1998 Kortenbach
5,709,334 A 1/1998 Sorrentino et al.
5,709,335 A 1/1998 Heck
5,709,680 A 1/1998 Yates et al.
5,709,706 A 1/1998 Kienzle et al.
5,711,472 A 1/1998 Bryan
5,712,460 A 1/1998 Carr et al.
5,713,128 A 2/1998 Schrenk et al.
5,713,505 A 2/1998 Huitema
5,713,895 A 2/1998 Lontine et al.
5,713,896 A 2/1998 Nardella
5,713,920 A 2/1998 Bezwada et al.
5,715,604 A 2/1998 Lanzoni
5,715,987 A 2/1998 Kelley et al.
5,715,988 A 2/1998 Palmer
5,716,366 A 2/1998 Yates
5,718,359 A 2/1998 Palmer et al.
5,718,360 A 2/1998 Green et al.
5,718,548 A 2/1998 Cotellessa
5,718,714 A 2/1998 Livneh
5,720,744 A 2/1998 Eggleston et al.
D393,067 S 3/1998 Geary et al.
5,724,025 A 3/1998 Tavori
5,725,536 A 3/1998 Oberlin et al.
5,725,554 A 3/1998 Simon et al.
5,728,110 A 3/1998 Vidal et al.
5,728,113 A 3/1998 Sherts
5,728,121 A 3/1998 Bimbo et al.
5,730,758 A 3/1998 Allgeyer
5,732,821 A 3/1998 Stone et al.
5,732,871 A 3/1998 Clark et al.
5,732,872 A 3/1998 Bolduc et al.
5,733,308 A 3/1998 Daugherty et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,735,445 A 4/1998 Vidal et al.
5,735,848 A 4/1998 Yates et al.
5,735,874 A 4/1998 Measamer et al.
5,738,474 A 4/1998 Blewett
5,738,629 A 4/1998 Moll et al.
5,738,648 A 4/1998 Lands et al.
5,741,271 A 4/1998 Nakao et al.
5,743,456 A 4/1998 Jones et al.
5,747,953 A 5/1998 Philipp
5,749,889 A 5/1998 Bacich et al.
5,749,893 A 5/1998 Vidal et al.
5,749,896 A 5/1998 Cook
5,749,968 A 5/1998 Melanson et al.
5,752,644 A 5/1998 Bolanos et al.
5,752,965 A 5/1998 Francis et al.
5,752,970 A 5/1998 Yoon
5,755,717 A 5/1998 Yates et al.
5,758,814 A 6/1998 Gallagher et al.
5,762,255 A 6/1998 Chrisman et al.
5,762,256 A 6/1998 Mastri et al.
5,765,565 A 6/1998 Adair
5,766,188 A 6/1998 Igaki
5,766,205 A 6/1998 Zvenyatsky et al.
5,769,303 A 6/1998 Knodel et al.
5,769,748 A 6/1998 Eyerly et al.
5,769,791 A 6/1998 Benaron et al.
5,769,892 A 6/1998 Kingwell
5,772,379 A 6/1998 Evensen
5,772,578 A 6/1998 Heimberger et al.
5,772,659 A 6/1998 Becker et al.
5,773,991 A 6/1998 Chen
5,776,130 A 7/1998 Buysse et al.
5,778,939 A 7/1998 Hok-Yin
5,779,130 A 7/1998 Alesi et al.
5,779,131 A 7/1998 Knodel et al.
5,779,132 A 7/1998 Knodel et al.
5,782,396 A 7/1998 Mastri et al.
5,782,397 A 7/1998 Koukline
5,782,748 A 7/1998 Palmer et al.
5,782,749 A 7/1998 Riza
5,782,859 A 7/1998 Nicholas et al.
5,784,934 A 7/1998 Izumisawa
5,785,232 A 7/1998 Vidal et al.
5,785,647 A 7/1998 Tompkins et al.
5,787,897 A 8/1998 Kieturakis
5,791,231 A 8/1998 Cohn et al.
5,792,135 A 8/1998 Madhani et al.
5,792,162 A 8/1998 Jolly et al.
5,792,165 A 8/1998 Klieman et al.
5,792,573 A 8/1998 Pitzen et al.
5,794,834 A 8/1998 Hamblin et al.
5,796,188 A 8/1998 Bays
5,797,536 A 8/1998 Smith et al.
5,797,537 A 8/1998 Oberlin et al.
5,797,538 A 8/1998 Heaton et al.
5,797,637 A 8/1998 Ervin
5,797,906 A 8/1998 Rhum et al.
5,797,927 A 8/1998 Yoon
5,797,941 A 8/1998 Schulze et al.
5,797,959 A 8/1998 Castro et al.
5,799,857 A 9/1998 Robertson et al.
5,800,379 A 9/1998 Edwards
5,800,423 A 9/1998 Jensen
5,804,726 A 9/1998 Geib et al.
5,804,936 A 9/1998 Brodsky et al.
5,806,676 A 9/1998 Wasgien
5,807,376 A 9/1998 Viola et al.
5,807,378 A 9/1998 Jensen et al.
5,807,393 A 9/1998 Williamson, IV et al.
5,809,441 A 9/1998 McKee
5,810,721 A 9/1998 Mueller et al.
5,810,811 A 9/1998 Yates et al.
5,810,846 A 9/1998 Virnich et al.
5,810,855 A 9/1998 Rayburn et al.
5,812,188 A 9/1998 Adair
5,813,813 A 9/1998 Daum et al.
5,814,055 A 9/1998 Knodel et al.
5,814,057 A 9/1998 Oi et al.
5,816,471 A 10/1998 Plyley et al.
5,817,084 A 10/1998 Jensen
5,817,091 A 10/1998 Nardella et al.
5,817,093 A 10/1998 Williamson, IV et al.
5,817,109 A 10/1998 McGarry et al.
5,817,119 A 10/1998 Klieman et al.
5,820,009 A 10/1998 Melling et al.
5,823,066 A 10/1998 Huitema et al.
5,824,333 A 10/1998 Scopelianos et al.
5,826,776 A 10/1998 Schulze et al.
5,827,271 A 10/1998 Buysse et al.
5,827,298 A 10/1998 Hart et al.
5,829,662 A 11/1998 Allen et al.
5,830,598 A 11/1998 Patterson
5,833,690 A 11/1998 Yates et al.
5,833,695 A 11/1998 Yoon
5,833,696 A 11/1998 Whitfield et al.
5,836,503 A 11/1998 Ehrenfels et al.
5,836,960 A 11/1998 Kolesa et al.
5,839,369 A 11/1998 Chatterjee et al.
5,839,639 A 11/1998 Sauer et al.
5,841,284 A 11/1998 Takahashi
5,843,021 A 12/1998 Edwards et al.
5,843,096 A 12/1998 Igaki et al.
5,843,097 A 12/1998 Mayenberger et al.
5,843,122 A 12/1998 Riza
5,843,132 A 12/1998 Ilvento
5,843,169 A 12/1998 Taheri
5,846,254 A 12/1998 Schulze et al.
5,847,566 A 12/1998 Marritt et al.
5,849,011 A 12/1998 Jones et al.
5,849,020 A 12/1998 Long et al.
5,849,023 A 12/1998 Mericle
5,851,179 A 12/1998 Ritson et al.
5,851,212 A 12/1998 Zirps et al.
5,853,366 A 12/1998 Dowlatshahi
5,855,311 A 1/1999 Hamblin et al.
5,855,583 A 1/1999 Wang et al.
5,860,581 A 1/1999 Robertson et al.
5,860,975 A 1/1999 Goble et al.
5,865,361 A 2/1999 Milliman et al.
5,865,638 A 2/1999 Trafton
5,868,361 A 2/1999 Rinderer
5,868,760 A 2/1999 McGuckin, Jr.
5,868,790 A 2/1999 Vincent et al.
5,871,135 A 2/1999 Williamson, IV et al.
5,873,885 A 2/1999 Weidenbenner
5,876,401 A 3/1999 Schulze et al.
5,878,193 A 3/1999 Wang et al.
5,878,607 A 3/1999 Nunes et al.
5,878,937 A 3/1999 Green et al.
5,878,938 A 3/1999 Bittner et al.
5,881,777 A 3/1999 Bassi et al.
5,891,094 A 4/1999 Masterson et al.
5,891,160 A 4/1999 Williamson, IV et al.
5,891,558 A 4/1999 Bell et al.
5,893,506 A 4/1999 Powell
5,893,835 A 4/1999 Witt et al.
5,893,878 A 4/1999 Pierce
5,894,979 A 4/1999 Powell
5,897,552 A 4/1999 Edwards et al.
5,897,562 A 4/1999 Bolanos et al.
5,899,824 A 5/1999 Kurtz et al.
5,899,914 A 5/1999 Zirps et al.
5,901,895 A 5/1999 Heaton et al.
5,902,312 A 5/1999 Frater et al.
5,903,117 A 5/1999 Gregory
5,904,647 A 5/1999 Ouchi
5,904,693 A 5/1999 Dicesare et al.
5,904,702 A 5/1999 Ek et al.
5,906,577 A 5/1999 Beane et al.
5,906,625 A 5/1999 Bito et al.
5,907,211 A 5/1999 Hall et al.
5,908,402 A 6/1999 Blythe
5,908,427 A 6/1999 McKean et al.
5,909,062 A 6/1999 Krietzman

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,911,353 A 6/1999 Bolanos et al.
5,915,616 A 6/1999 Viola et al.
5,916,225 A 6/1999 Kugel
5,918,791 A 7/1999 Sorrentino et al.
5,919,198 A 7/1999 Graves, Jr. et al.
5,921,956 A 7/1999 Grinberg et al.
5,924,864 A 7/1999 Loge et al.
5,928,137 A 7/1999 Green
5,928,256 A 7/1999 Riza
5,931,847 A 8/1999 Bittner et al.
5,931,853 A 8/1999 McEwen et al.
5,937,951 A 8/1999 Izuchukwu et al.
5,938,667 A 8/1999 Peyser et al.
5,941,442 A 8/1999 Geiste et al.
5,941,890 A 8/1999 Voegele et al.
5,944,172 A 8/1999 Hannula
5,944,715 A 8/1999 Goble et al.
5,946,978 A 9/1999 Yamashita
5,947,984 A 9/1999 Whipple
5,947,996 A 9/1999 Logeman
5,948,030 A 9/1999 Miller et al.
5,948,429 A 9/1999 Bell et al.
5,951,301 A 9/1999 Younker
5,951,516 A 9/1999 Bunyan
5,951,552 A 9/1999 Long et al.
5,951,574 A 9/1999 Stefanchik et al.
5,951,575 A 9/1999 Bolduc et al.
5,951,581 A 9/1999 Saadat et al.
5,954,259 A 9/1999 Viola et al.
5,957,831 A 9/1999 Adair
5,964,394 A 10/1999 Robertson
5,964,774 A 10/1999 McKean et al.
5,966,126 A 10/1999 Szabo
5,971,916 A 10/1999 Koren
5,973,221 A 10/1999 Collyer et al.
D416,089 S 11/1999 Barton et al.
5,976,122 A 11/1999 Madhani et al.
5,977,746 A 11/1999 Hershberger et al.
5,980,248 A 11/1999 Kusakabe et al.
5,984,949 A 11/1999 Levin
5,988,479 A 11/1999 Palmer
5,990,379 A 11/1999 Gregory
5,993,466 A 11/1999 Yoon
5,997,528 A 12/1999 Bisch et al.
5,997,552 A 12/1999 Person et al.
6,001,108 A 12/1999 Wang et al.
6,003,517 A 12/1999 Sheffield et al.
6,004,319 A 12/1999 Goble et al.
6,004,335 A 12/1999 Vaitekunas et al.
6,007,521 A 12/1999 Bidwell et al.
6,010,054 A 1/2000 Johnson et al.
6,010,513 A 1/2000 Tormala et al.
6,010,520 A 1/2000 Pattison
6,012,494 A 1/2000 Balazs
6,013,076 A 1/2000 Goble et al.
6,015,406 A 1/2000 Goble et al.
6,015,417 A 1/2000 Reynolds, Jr.
6,017,322 A 1/2000 Snoke et al.
6,017,354 A 1/2000 Culp et al.
6,017,356 A 1/2000 Frederick et al.
6,018,227 A 1/2000 Kumar et al.
6,019,745 A 2/2000 Gray
6,022,352 A 2/2000 Vandewalle
6,023,641 A 2/2000 Thompson
6,024,708 A 2/2000 Bales et al.
6,024,741 A 2/2000 Williamson, IV et al.
6,024,748 A 2/2000 Manzo et al.
6,024,750 A 2/2000 Mastri et al.
6,024,764 A 2/2000 Schroeppel
6,027,501 A 2/2000 Goble et al.
6,030,384 A 2/2000 Nezhat
6,032,849 A 3/2000 Mastri et al.
6,033,105 A 3/2000 Barker et al.
6,033,378 A 3/2000 Lundquist et al.
6,033,399 A 3/2000 Gines
6,033,427 A 3/2000 Lee
6,036,641 A 3/2000 Taylor et al.
6,036,667 A 3/2000 Manna et al.
6,037,724 A 3/2000 Buss et al.
6,037,927 A 3/2000 Rosenberg
6,039,733 A 3/2000 Buysse et al.
6,039,734 A 3/2000 Goble
6,042,601 A 3/2000 Smith
6,042,607 A 3/2000 Williamson, IV et al.
6,043,626 A 3/2000 Snyder et al.
6,045,560 A 4/2000 McKean et al.
6,047,861 A 4/2000 Vidal et al.
6,049,145 A 4/2000 Austin et al.
6,050,172 A 4/2000 Corves et al.
6,050,472 A 4/2000 Shibata
6,050,989 A 4/2000 Fox et al.
6,050,990 A 4/2000 Tankovich et al.
6,050,996 A 4/2000 Schmaltz et al.
6,053,390 A 4/2000 Green et al.
6,053,899 A 4/2000 Slanda et al.
6,053,922 A 4/2000 Krause et al.
6,054,142 A 4/2000 Li et al.
RE36,720 E 5/2000 Green et al.
6,056,735 A 5/2000 Okada et al.
6,056,746 A 5/2000 Goble et al.
6,059,806 A 5/2000 Hoegerle
6,062,360 A 5/2000 Shields
6,063,020 A 5/2000 Jones et al.
6,063,025 A 5/2000 Bridges et al.
6,063,050 A 5/2000 Manna et al.
6,063,095 A 5/2000 Wang et al.
6,063,097 A 5/2000 Oi et al.
6,063,098 A 5/2000 Houser et al.
6,065,679 A 5/2000 Levie et al.
6,065,919 A 5/2000 Peck
6,066,132 A 5/2000 Chen et al.
6,066,151 A 5/2000 Miyawaki et al.
6,068,627 A 5/2000 Orszulak et al.
6,071,233 A 6/2000 Ishikawa et al.
6,074,386 A 6/2000 Goble et al.
6,074,401 A 6/2000 Gardiner et al.
6,077,280 A 6/2000 Fossum
6,077,286 A 6/2000 Cuschieri et al.
6,077,290 A 6/2000 Marini
6,079,606 A 6/2000 Milliman et al.
6,080,181 A 6/2000 Jensen et al.
6,082,577 A 7/2000 Coates et al.
6,083,191 A 7/2000 Rose
6,083,223 A 7/2000 Baker
6,083,234 A 7/2000 Nicholas et al.
6,083,242 A 7/2000 Cook
6,086,544 A 7/2000 Hibner et al.
6,086,600 A 7/2000 Kortenbach
6,090,106 A 7/2000 Goble et al.
6,093,186 A 7/2000 Goble
6,099,537 A 8/2000 Sugai et al.
6,099,551 A 8/2000 Gabbay
6,102,271 A 8/2000 Longo et al.
6,104,162 A 8/2000 Sainsbury et al.
6,104,304 A 8/2000 Clark et al.
6,106,511 A 8/2000 Jensen
6,109,500 A 8/2000 Alli et al.
6,110,187 A 8/2000 Donlon
6,113,618 A 9/2000 Nic
6,117,148 A 9/2000 Ravo et al.
6,117,158 A 9/2000 Measamer et al.
6,119,913 A 9/2000 Adams et al.
6,120,433 A 9/2000 Mizuno et al.
6,120,462 A 9/2000 Hibner et al.
6,123,241 A 9/2000 Walter et al.
6,123,701 A 9/2000 Nezhat
H1904 H 10/2000 Yates et al.
6,126,058 A 10/2000 Adams et al.
6,126,359 A 10/2000 Dittrich et al.
6,126,670 A 10/2000 Walker et al.
6,131,789 A 10/2000 Schulze et al.
6,131,790 A 10/2000 Piraka
6,132,368 A 10/2000 Cooper
6,134,962 A 10/2000 Sugitani

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,139,546 A 10/2000 Koenig et al.
6,142,149 A 11/2000 Steen
6,142,933 A 11/2000 Longo et al.
6,147,135 A 11/2000 Yuan et al.
6,149,660 A 11/2000 Laufer et al.
6,151,323 A 11/2000 O'Connell et al.
6,152,935 A 11/2000 Kammerer et al.
6,155,473 A 12/2000 Tompkins et al.
6,156,056 A 12/2000 Kearns et al.
6,157,169 A 12/2000 Lee
6,159,146 A 12/2000 El Gazayerli
6,159,200 A 12/2000 Verdura et al.
6,159,224 A 12/2000 Yoon
6,162,208 A 12/2000 Hipps
6,162,220 A 12/2000 Nezhat
6,162,537 A 12/2000 Martin et al.
6,165,175 A 12/2000 Wampler et al.
6,165,184 A 12/2000 Verdura et al.
6,165,188 A 12/2000 Saadat et al.
6,167,185 A 12/2000 Smiley et al.
6,168,605 B1 1/2001 Measamer et al.
6,171,305 B1 1/2001 Sherman
6,171,316 B1 1/2001 Kovac et al.
6,171,330 B1 1/2001 Benchetrit
6,173,074 B1 1/2001 Russo
6,174,308 B1 1/2001 Goble et al.
6,174,309 B1 1/2001 Wrublewski et al.
6,174,318 B1 1/2001 Bates et al.
6,175,290 B1 1/2001 Forsythe et al.
6,179,195 B1 1/2001 Adams et al.
6,179,776 B1 1/2001 Adams et al.
6,181,105 B1 1/2001 Cutolo et al.
6,182,673 B1 2/2001 Kindermann et al.
6,185,356 B1 2/2001 Parker et al.
6,186,142 B1 2/2001 Schmidt et al.
6,187,003 B1 2/2001 Buysse et al.
6,190,386 B1 2/2001 Rydell
6,193,129 B1 2/2001 Bittner et al.
6,197,042 B1 3/2001 Ginn et al.
6,200,330 B1 3/2001 Benderev et al.
6,202,914 B1 3/2001 Geiste et al.
6,206,894 B1 3/2001 Thompson et al.
6,206,897 B1 3/2001 Jamiolkowski et al.
6,206,903 B1 3/2001 Ramans
6,206,904 B1 3/2001 Ouchi
6,209,414 B1 4/2001 Uneme
6,210,403 B1 4/2001 Klicek
6,213,999 B1 4/2001 Platt, Jr. et al.
6,214,028 B1 4/2001 Yoon et al.
6,220,368 B1 4/2001 Ark et al.
6,221,007 B1 4/2001 Green
6,221,023 B1 4/2001 Matsuba et al.
6,223,100 B1 4/2001 Green
6,223,835 B1 5/2001 Habedank et al.
6,224,617 B1 5/2001 Saadat et al.
6,228,080 B1 5/2001 Gines
6,228,081 B1 5/2001 Goble
6,228,083 B1 5/2001 Lands et al.
6,228,084 B1 5/2001 Kirwan, Jr.
6,228,089 B1 5/2001 Wahrburg
6,228,098 B1 5/2001 Kayan et al.
6,231,565 B1 5/2001 Tovey et al.
6,234,178 B1 5/2001 Goble et al.
6,237,604 B1 5/2001 Burnside et al.
6,238,384 B1 5/2001 Peer
6,241,139 B1 6/2001 Milliman et al.
6,241,140 B1 6/2001 Adams et al.
6,241,723 B1 6/2001 Heim et al.
6,245,084 B1 6/2001 Mark et al.
6,248,116 B1 6/2001 Chevillon et al.
6,248,117 B1 6/2001 Blatter
6,249,076 B1 6/2001 Madden et al.
6,249,105 B1 6/2001 Andrews et al.
6,250,532 B1 6/2001 Green et al.
6,251,485 B1 6/2001 Harris et al.
D445,745 S 7/2001 Norman
6,254,534 B1 7/2001 Butler et al.
6,254,619 B1 7/2001 Garabet et al.
6,254,642 B1 7/2001 Taylor
6,258,107 B1 7/2001 Balazs et al.
6,261,286 B1 7/2001 Goble et al.
6,261,679 B1 7/2001 Chen et al.
6,264,086 B1 7/2001 McGuckin, Jr.
6,264,087 B1 7/2001 Whitman
6,264,617 B1 7/2001 Bales et al.
6,270,508 B1 8/2001 Klieman et al.
6,270,916 B1 8/2001 Sink et al.
6,273,252 B1 8/2001 Mitchell
6,273,876 B1 8/2001 Klima et al.
6,273,897 B1 8/2001 Dalessandro et al.
6,277,114 B1 8/2001 Bullivant et al.
6,280,407 B1 8/2001 Manna et al.
6,283,981 B1 9/2001 Beaupre
6,293,927 B1 9/2001 McGuckin, Jr.
6,293,942 B1 9/2001 Goble et al.
6,296,640 B1 10/2001 Wampler et al.
6,302,311 B1 10/2001 Adams et al.
6,302,743 B1 10/2001 Chiu et al.
6,305,891 B1 10/2001 Burlingame
6,306,134 B1 10/2001 Goble et al.
6,306,149 B1 10/2001 Meade
6,306,424 B1 10/2001 Vyakarnam et al.
6,309,397 B1 10/2001 Julian et al.
6,309,400 B2 10/2001 Beaupre
6,309,403 B1 10/2001 Minor et al.
6,312,435 B1 11/2001 Wallace et al.
6,315,184 B1 11/2001 Whitman
6,319,510 B1 11/2001 Yates
6,320,123 B1 11/2001 Reimers
6,322,494 B1 11/2001 Bullivant et al.
6,324,339 B1 11/2001 Hudson et al.
6,325,799 B1 12/2001 Goble
6,325,805 B1 12/2001 Ogilvie et al.
6,325,810 B1 12/2001 Hamilton et al.
6,328,498 B1 12/2001 Mersch
6,330,965 B1 12/2001 Milliman et al.
6,331,181 B1 12/2001 Tierney et al.
6,331,761 B1 12/2001 Kumar et al.
6,333,029 B1 12/2001 Vyakarnam et al.
6,334,860 B1 1/2002 Dorn
6,334,861 B1 1/2002 Chandler et al.
6,336,926 B1 1/2002 Goble
6,338,737 B1 1/2002 Toledano
6,343,731 B1 2/2002 Adams et al.
6,346,077 B1 2/2002 Taylor et al.
6,348,061 B1 2/2002 Whitman
D454,951 S 3/2002 Bon
6,352,503 B1 3/2002 Matsui et al.
6,352,532 B1 3/2002 Kramer et al.
6,355,699 B1 3/2002 Vyakarnam et al.
6,356,072 B1 3/2002 Chass
6,358,224 B1 3/2002 Tims et al.
6,358,263 B2 3/2002 Mark et al.
6,358,459 B1 3/2002 Ziegler et al.
6,364,877 B1 4/2002 Goble et al.
6,364,888 B1 4/2002 Niemeyer et al.
6,366,441 B1 4/2002 Ozawa et al.
6,370,981 B2 4/2002 Watarai
6,371,114 B1 4/2002 Schmidt et al.
6,373,152 B1 4/2002 Wang et al.
6,377,011 B1 4/2002 Ben-Ur
6,383,201 B1 5/2002 Dong
6,387,092 B1 5/2002 Burnside et al.
6,387,113 B1 5/2002 Hawkins et al.
6,387,114 B2 5/2002 Adams
6,391,038 B2 5/2002 Vargas et al.
6,392,854 B1 5/2002 O'Gorman
6,394,998 B1 5/2002 Wallace et al.
6,398,779 B1 6/2002 Buysse et al.
6,398,781 B1 6/2002 Goble et al.
6,398,797 B2 6/2002 Bombard et al.
6,402,766 B2 6/2002 Bowman et al.
6,406,440 B1 6/2002 Stefanchik
6,406,472 B1 6/2002 Jensen

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,409,724 B1 6/2002 Penny et al.
H2037 H 7/2002 Yates et al.
6,412,639 B1 7/2002 Hickey
6,413,274 B1 7/2002 Pedros
6,415,542 B1 7/2002 Bates et al.
6,416,486 B1 7/2002 Wampler
6,416,509 B1 7/2002 Goble et al.
6,419,695 B1 7/2002 Gabbay
6,423,079 B1 7/2002 Blake, III
6,424,885 B1 7/2002 Niemeyer et al.
RE37,814 E 8/2002 Allgeyer
6,428,070 B1 8/2002 Takanashi et al.
6,428,487 B1 8/2002 Burdorff et al.
6,429,611 B1 8/2002 Li
6,430,298 B1 8/2002 Kettl et al.
6,432,065 B1 8/2002 Burdorff et al.
6,436,097 B1 8/2002 Nardella
6,436,107 B1 8/2002 Wang et al.
6,436,110 B2 8/2002 Bowman et al.
6,436,115 B1 8/2002 Beaupre
6,436,122 B1 8/2002 Frank et al.
6,439,439 B1 8/2002 Rickard et al.
6,439,446 B1 8/2002 Perry et al.
6,440,146 B2 8/2002 Nicholas et al.
6,441,577 B2 8/2002 Blumenkranz et al.
D462,758 S 9/2002 Epstein et al.
6,443,973 B1 9/2002 Whitman
6,445,530 B1 9/2002 Baker
6,447,518 B1 9/2002 Krause et al.
6,447,523 B1 9/2002 Middleman et al.
6,447,799 B1 9/2002 Ullman
6,447,864 B2 9/2002 Johnson et al.
6,450,391 B1 9/2002 Kayan et al.
6,450,989 B2 9/2002 Dubrul et al.
6,454,781 B1 9/2002 Witt et al.
6,457,625 B1 10/2002 Tormala et al.
6,458,077 B1 10/2002 Boebel et al.
6,458,147 B1 10/2002 Cruise et al.
6,460,627 B1 10/2002 Below et al.
6,468,275 B1 10/2002 Wampler et al.
6,468,286 B2 10/2002 Mastri et al.
6,471,106 B1 10/2002 Reining
6,471,659 B2 10/2002 Eggers et al.
6,478,210 B2 11/2002 Adams et al.
6,482,200 B2 11/2002 Shippert
6,482,217 B1 11/2002 Pintor et al.
6,485,490 B2 11/2002 Wampler et al.
6,485,503 B2 11/2002 Jacobs et al.
6,485,667 B1 11/2002 Tan
6,486,286 B1 11/2002 McGall et al.
6,488,196 B1 12/2002 Fenton, Jr.
6,488,197 B1 12/2002 Whitman
6,488,659 B1 12/2002 Rosenman
6,491,201 B1 12/2002 Whitman
6,491,690 B1 12/2002 Goble et al.
6,491,701 B2 12/2002 Tierney et al.
6,491,702 B2 12/2002 Heilbrun et al.
6,492,785 B1 12/2002 Kasten et al.
6,494,882 B1 12/2002 Lebouitz et al.
6,494,885 B1 12/2002 Dhindsa
6,494,888 B1 12/2002 Laufer et al.
6,494,896 B1 12/2002 D'Alessio et al.
6,498,480 B1 12/2002 Manara
6,500,176 B1 12/2002 Truckai et al.
6,500,194 B2 12/2002 Benderev et al.
6,503,139 B2 1/2003 Coral
6,503,257 B2 1/2003 Grant et al.
6,503,259 B2 1/2003 Huxel et al.
6,505,768 B2 1/2003 Whitman
6,506,197 B1 1/2003 Rollero et al.
6,510,854 B2 1/2003 Goble
6,511,468 B1 1/2003 Cragg et al.
6,512,360 B1 1/2003 Goto et al.
6,514,252 B2 2/2003 Nezhat et al.
6,516,073 B1 2/2003 Schulz et al.
6,517,528 B1 2/2003 Pantages et al.
6,517,535 B2 2/2003 Edwards
6,517,565 B1 2/2003 Whitman et al.
6,517,566 B1 2/2003 Hovland et al.
6,520,971 B1 2/2003 Perry et al.
6,520,972 B2 2/2003 Peters
6,522,101 B2 2/2003 Malackowski
6,524,180 B1 2/2003 Simms et al.
6,525,499 B2 2/2003 Naganuma
6,527,782 B2 3/2003 Hogg et al.
6,527,785 B2 3/2003 Sancoff et al.
6,530,942 B2 3/2003 Fogarty et al.
6,532,958 B1 3/2003 Buan et al.
6,533,157 B1 3/2003 Whitman
6,533,723 B1 3/2003 Lockery et al.
6,533,784 B2 3/2003 Truckai et al.
6,535,764 B2 3/2003 Imran et al.
6,539,297 B2 3/2003 Weiberle et al.
D473,239 S 4/2003 Cockerill
6,539,816 B2 4/2003 Kogiso et al.
6,543,456 B1 4/2003 Freeman
6,545,384 B1 4/2003 Pelrine et al.
6,547,786 B1 4/2003 Goble
6,550,546 B2 4/2003 Thurler et al.
6,551,333 B2 4/2003 Kuhns et al.
6,554,861 B2 4/2003 Knox et al.
6,555,770 B2 4/2003 Kawase
6,558,378 B2 5/2003 Sherman et al.
6,558,379 B1 5/2003 Batchelor et al.
6,558,429 B2 5/2003 Taylor
6,561,187 B2 5/2003 Schmidt et al.
6,565,560 B1 5/2003 Goble et al.
6,566,619 B2 5/2003 Gillman et al.
6,569,085 B2 5/2003 Kortenbach et al.
6,569,171 B2 5/2003 DeGuillebon et al.
6,578,751 B2 6/2003 Hartwick
6,582,364 B2 6/2003 Butler et al.
6,582,427 B1 6/2003 Goble et al.
6,582,441 B1 6/2003 He et al.
6,583,533 B2 6/2003 Pelrine et al.
6,585,144 B2 7/2003 Adams et al.
6,585,664 B2 7/2003 Burdorff et al.
6,586,898 B2 7/2003 King et al.
6,587,750 B2 7/2003 Gerbi et al.
6,588,277 B2 7/2003 Giordano et al.
6,588,643 B2 7/2003 Bolduc et al.
6,588,931 B2 7/2003 Betzner et al.
6,589,118 B1 7/2003 Soma et al.
6,589,164 B1 7/2003 Flaherty
6,592,538 B1 7/2003 Hotchkiss et al.
6,592,597 B2 7/2003 Grant et al.
6,594,552 B1 7/2003 Nowlin et al.
6,596,296 B1 7/2003 Nelson et al.
6,596,304 B1 7/2003 Bayon et al.
6,596,432 B2 7/2003 Kawakami et al.
6,599,295 B1 7/2003 Tornier et al.
6,599,323 B2 7/2003 Melican et al.
D478,665 S 8/2003 Isaacs et al.
D478,986 S 8/2003 Johnston et al.
6,601,749 B2 8/2003 Sullivan et al.
6,602,252 B2 8/2003 Mollenauer
6,602,262 B2 8/2003 Griego et al.
6,603,050 B2 8/2003 Heaton
6,605,078 B2 8/2003 Adams
6,605,669 B2 8/2003 Awokola et al.
6,605,911 B1 8/2003 Klesing
6,607,475 B2 8/2003 Doyle et al.
6,611,793 B1 8/2003 Burnside et al.
6,613,069 B2 9/2003 Boyd et al.
6,616,686 B2 9/2003 Coleman et al.
6,619,529 B2 9/2003 Green et al.
6,620,111 B2 9/2003 Stephens et al.
6,620,161 B2 9/2003 Schulze et al.
6,620,166 B1 9/2003 Wenstrom, Jr. et al.
6,625,517 B1 9/2003 Bogdanov et al.
6,626,834 B2 9/2003 Dunne et al.
H2086 H 10/2003 Amsler
6,629,630 B2 10/2003 Adams
6,629,974 B2 10/2003 Penny et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,629,988 B2 10/2003 Weadock
6,635,838 B1 10/2003 Kornelson
6,636,412 B2 10/2003 Smith
6,638,108 B2 10/2003 Tachi
6,638,285 B2 10/2003 Gabbay
6,638,297 B1 10/2003 Huitema
RE38,335 E 11/2003 Aust et al.
6,641,528 B2 11/2003 Torii
6,644,532 B2 11/2003 Green et al.
6,645,201 B1 11/2003 Utley et al.
6,646,307 B1 11/2003 Yu et al.
6,648,816 B2 11/2003 Irion et al.
6,648,901 B2 11/2003 Fleischman et al.
6,652,595 B1 11/2003 Nicolo
D484,243 S 12/2003 Ryan et al.
D484,595 S 12/2003 Ryan et al.
D484,596 S 12/2003 Ryan et al.
6,656,177 B2 12/2003 Truckai et al.
6,656,193 B2 12/2003 Grant et al.
6,659,940 B2 12/2003 Adler
6,660,008 B1 12/2003 Foerster et al.
6,663,623 B1 12/2003 Oyama et al.
6,663,641 B1 12/2003 Kovac et al.
6,666,854 B1 12/2003 Lange
6,666,875 B1 12/2003 Sakurai et al.
6,667,825 B2 12/2003 Lu et al.
6,669,073 B2 12/2003 Milliman et al.
6,670,806 B2 12/2003 Wendt et al.
6,671,185 B2 12/2003 Duval
D484,977 S 1/2004 Ryan et al.
6,676,660 B2 1/2004 Wampler et al.
6,677,687 B2 1/2004 Ho et al.
6,679,269 B2 1/2004 Swanson
6,679,410 B2 1/2004 Wursch et al.
6,681,978 B2 1/2004 Geiste et al.
6,681,979 B2 1/2004 Whitman
6,682,527 B2 1/2004 Strul
6,682,528 B2 1/2004 Frazier et al.
6,682,544 B2 1/2004 Mastri et al.
6,685,698 B2 2/2004 Morley et al.
6,685,727 B2 2/2004 Fisher et al.
6,689,153 B1 2/2004 Skiba
6,692,507 B2 2/2004 Pugsley et al.
6,692,692 B2 2/2004 Stetzel
6,695,198 B2 2/2004 Adams et al.
6,695,199 B2 2/2004 Whitman
6,695,774 B2 2/2004 Hale et al.
6,695,849 B2 2/2004 Michelson
6,696,814 B2 2/2004 Henderson et al.
6,697,048 B2 2/2004 Rosenberg et al.
6,698,643 B2 3/2004 Whitman
6,699,177 B1 3/2004 Wang et al.
6,699,214 B2 3/2004 Gellman
6,699,235 B2 3/2004 Wallace et al.
6,704,210 B1 3/2004 Myers
6,705,503 B1 3/2004 Pedicini et al.
6,709,445 B2 3/2004 Boebel et al.
6,712,773 B1 3/2004 Viola
6,716,223 B2 4/2004 Leopold et al.
6,716,232 B1 4/2004 Vidal et al.
6,716,233 B1 4/2004 Whitman
6,720,734 B2 4/2004 Norris
6,722,550 B1 4/2004 Ricordi et al.
6,722,552 B2 4/2004 Fenton, Jr.
6,723,087 B2 4/2004 O'Neill et al.
6,723,091 B2 4/2004 Goble et al.
6,723,109 B2 4/2004 Solingen
6,726,697 B2 4/2004 Nicholas et al.
6,726,706 B2 4/2004 Dominguez
6,729,119 B2 5/2004 Schnipke et al.
6,736,825 B2 5/2004 Blatter et al.
6,736,854 B2 5/2004 Vadurro et al.
6,740,030 B2 5/2004 Martone et al.
6,743,230 B2 6/2004 Lutze et al.
6,744,385 B2 6/2004 Kazuya et al.
6,747,121 B2 6/2004 Gogolewski
6,747,300 B2 6/2004 Nadd et al.
6,749,560 B1 6/2004 Konstorum et al.
6,749,600 B1 6/2004 Levy
6,752,768 B2 6/2004 Burdorff et al.
6,752,816 B2 6/2004 Culp et al.
6,754,959 B1 6/2004 Guiette, III et al.
6,755,195 B1 6/2004 Lemke et al.
6,755,338 B2 6/2004 Hahnen et al.
6,755,843 B2 6/2004 Chung et al.
6,756,705 B2 6/2004 Pulford, Jr.
6,758,846 B2 7/2004 Goble et al.
6,761,685 B2 7/2004 Adams et al.
6,762,339 B1 7/2004 Klun et al.
6,764,445 B2 7/2004 Ramans et al.
6,766,957 B2 7/2004 Matsuura et al.
6,767,352 B2 7/2004 Field et al.
6,767,356 B2 7/2004 Kanner et al.
6,769,590 B2 8/2004 Vresh et al.
6,769,594 B2 8/2004 Orban, III
6,770,027 B2 8/2004 Banik et al.
6,770,070 B1 8/2004 Balbierz
6,770,072 B1 8/2004 Truckai et al.
6,770,078 B2 8/2004 Bonutti
6,773,409 B2 8/2004 Truckai et al.
6,773,437 B2 8/2004 Ogilvie et al.
6,773,438 B1 8/2004 Knodel et al.
6,775,575 B2 8/2004 Bommannan et al.
6,777,838 B2 8/2004 Miekka et al.
6,780,151 B2 8/2004 Grabover et al.
6,780,180 B1 8/2004 Goble et al.
6,783,524 B2 8/2004 Anderson et al.
6,786,382 B1 9/2004 Hoffman
6,786,864 B2 9/2004 Matsuura et al.
6,786,896 B1 9/2004 Madhani et al.
6,788,018 B1 9/2004 Blumenkranz
6,790,173 B2 9/2004 Saadat et al.
6,793,652 B1 9/2004 Whitman et al.
6,793,661 B2 9/2004 Hamilton et al.
6,793,663 B2 9/2004 Kneifel et al.
6,793,669 B2 9/2004 Nakamura et al.
6,796,921 B1 9/2004 Buck et al.
6,799,669 B2 10/2004 Fukumura et al.
6,802,822 B1 10/2004 Dodge
6,802,843 B2 10/2004 Truckai et al.
6,802,844 B2 10/2004 Ferree
6,805,273 B2 10/2004 Bilotti et al.
6,806,808 B1 10/2004 Watters et al.
6,808,525 B2 10/2004 Latterell et al.
6,810,359 B2 10/2004 Sakaguchi
6,814,154 B2 11/2004 Chou
6,814,741 B2 11/2004 Bowman et al.
6,817,508 B1 11/2004 Racenet et al.
6,817,509 B2 11/2004 Geiste et al.
6,817,974 B2 11/2004 Cooper et al.
6,818,018 B1 11/2004 Sawhney
6,820,791 B2 11/2004 Adams
6,821,273 B2 11/2004 Mollenauer
6,821,282 B2 11/2004 Perry et al.
6,821,284 B2 11/2004 Sturtz et al.
6,827,246 B2 12/2004 Sullivan et al.
6,827,712 B2 12/2004 Tovey et al.
6,827,725 B2 12/2004 Batchelor et al.
6,828,902 B2 12/2004 Casden
6,830,174 B2 12/2004 Hillstead et al.
6,831,629 B2 12/2004 Nishino et al.
6,832,998 B2 12/2004 Goble
6,834,001 B2 12/2004 Myono
6,835,173 B2 12/2004 Couvillon, Jr.
6,835,199 B2 12/2004 McGuckin, Jr. et al.
6,835,336 B2 12/2004 Watt
6,836,611 B2 12/2004 Popovic et al.
6,837,846 B2 1/2005 Jaffe et al.
6,837,883 B2 1/2005 Moll et al.
6,838,493 B2 1/2005 Williams et al.
6,840,423 B2 1/2005 Adams et al.
6,841,967 B2 1/2005 Kim et al.
6,843,403 B2 1/2005 Whitman
6,843,789 B2 1/2005 Goble

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,843,793 B2 1/2005 Brock et al.
6,846,307 B2 1/2005 Whitman et al.
6,846,308 B2 1/2005 Whitman et al.
6,846,309 B2 1/2005 Whitman et al.
6,847,190 B2 1/2005 Schaefer et al.
6,849,071 B2 2/2005 Whitman et al.
6,850,817 B1 2/2005 Green
6,852,122 B2 2/2005 Rush
6,852,330 B2 2/2005 Bowman et al.
6,853,879 B2 2/2005 Sunaoshi
6,858,005 B2 2/2005 Ohline et al.
6,859,882 B2 2/2005 Fung
RE38,708 E 3/2005 Bolanos et al.
D502,994 S 3/2005 Blake, III
6,861,142 B1 3/2005 Wilkie et al.
6,861,954 B2 3/2005 Levin
6,863,668 B2 3/2005 Gillespie et al.
6,863,694 B1 3/2005 Boyce et al.
6,863,924 B2 3/2005 Ranganathan et al.
6,866,178 B2 3/2005 Adams et al.
6,866,668 B2 3/2005 Giannetti et al.
6,866,671 B2 3/2005 Tierney et al.
6,867,248 B1 3/2005 Martin et al.
6,869,430 B2 3/2005 Balbierz et al.
6,869,435 B2 3/2005 Blake, III
6,872,214 B2 3/2005 Sonnenschein et al.
6,874,669 B2 4/2005 Adams et al.
6,877,647 B2 4/2005 Green et al.
6,878,106 B1 4/2005 Herrmann
6,884,392 B2 4/2005 Malkin et al.
6,884,428 B2 4/2005 Binette et al.
6,886,730 B2 5/2005 Fujisawa et al.
6,887,710 B2 5/2005 Call et al.
6,889,116 B2 5/2005 Jinno
6,893,435 B2 5/2005 Goble
6,894,140 B2 5/2005 Roby
6,895,176 B2 5/2005 Archer et al.
6,899,538 B2 5/2005 Matoba
6,899,593 B1 5/2005 Moeller et al.
6,899,915 B2 5/2005 Yelick et al.
6,905,057 B2 6/2005 Swayze et al.
6,905,497 B2 6/2005 Truckai et al.
6,905,498 B2 6/2005 Hooven
6,908,472 B2 6/2005 Wiener et al.
6,911,033 B2 6/2005 de Guillebon et al.
6,911,916 B1 6/2005 Wang et al.
6,913,579 B2 7/2005 Truckai et al.
6,913,608 B2 7/2005 Liddicoat et al.
6,913,613 B2 7/2005 Schwarz et al.
6,921,397 B2 7/2005 Corcoran et al.
6,921,412 B1 7/2005 Black et al.
6,923,093 B2 8/2005 Ullah
6,923,803 B2 8/2005 Goble
6,923,819 B2 8/2005 Meade et al.
6,925,849 B2 8/2005 Jairam
6,926,716 B2 8/2005 Baker et al.
6,928,902 B1 8/2005 Eyssallenne
6,929,641 B2 8/2005 Goble et al.
6,929,644 B2 8/2005 Truckai et al.
6,931,830 B2 8/2005 Liao
6,932,218 B2 8/2005 Kosann et al.
6,932,810 B2 8/2005 Ryan
6,936,042 B2 8/2005 Wallace et al.
6,936,948 B2 8/2005 Bell et al.
D509,297 S 9/2005 Wells
D509,589 S 9/2005 Wells
6,938,706 B2 9/2005 Ng
6,939,358 B2 9/2005 Palacios et al.
6,942,662 B2 9/2005 Goble et al.
6,942,674 B2 9/2005 Belef et al.
6,945,444 B2 9/2005 Gresham et al.
6,945,981 B2 9/2005 Donofrio et al.
6,951,562 B2 10/2005 Zwirnmann
6,953,138 B1 10/2005 Dworak et al.
6,953,139 B2 10/2005 Milliman et al.
6,953,461 B2 10/2005 McClurken et al.
6,957,758 B2 10/2005 Aranyi
6,958,035 B2 10/2005 Friedman et al.
6,959,851 B2 11/2005 Heinrich
6,959,852 B2 11/2005 Shelton, IV et al.
6,960,107 B1 11/2005 Schaub et al.
6,960,163 B2 11/2005 Ewers et al.
6,960,220 B2 11/2005 Marino et al.
6,962,587 B2 11/2005 Johnson et al.
6,963,792 B1 11/2005 Green
6,964,363 B2 11/2005 Wales et al.
6,966,907 B2 11/2005 Goble
6,966,909 B2 11/2005 Marshall et al.
6,968,908 B2 11/2005 Tokunaga et al.
6,969,385 B2 11/2005 Moreyra
6,969,395 B2 11/2005 Eskuri
6,971,988 B2 12/2005 Orban, III
6,972,199 B2 12/2005 Lebouitz et al.
6,974,435 B2 12/2005 Daw et al.
6,974,462 B2 12/2005 Sater
6,978,921 B2 12/2005 Shelton, IV et al.
6,978,922 B2 12/2005 Bilotti et al.
6,981,628 B2 1/2006 Wales
6,981,941 B2 1/2006 Whitman et al.
6,981,978 B2 1/2006 Gannoe
6,984,203 B2 1/2006 Tartaglia et al.
6,984,231 B2 1/2006 Goble et al.
6,986,451 B1 1/2006 Mastri et al.
6,988,649 B2 1/2006 Shelton, IV et al.
6,988,650 B2 1/2006 Schwemberger et al.
6,989,034 B2 1/2006 Hammer et al.
6,990,731 B2 1/2006 Haytayan
6,990,796 B2 1/2006 Schnipke et al.
6,993,200 B2 1/2006 Tastl et al.
6,993,413 B2 1/2006 Sunaoshi
6,994,708 B2 2/2006 Manzo
6,995,729 B2 2/2006 Govari et al.
6,996,433 B2 2/2006 Burbank et al.
6,997,931 B2 2/2006 Sauer et al.
6,997,935 B2 2/2006 Anderson et al.
6,998,736 B2 2/2006 Lee et al.
6,998,816 B2 2/2006 Wieck et al.
7,000,818 B2 2/2006 Shelton, IV et al.
7,000,819 B2 2/2006 Swayze et al.
7,000,911 B2 2/2006 McCormick et al.
7,001,380 B2 2/2006 Goble
7,001,408 B2 2/2006 Knodel et al.
7,004,174 B2 2/2006 Eggers et al.
7,007,176 B2 2/2006 Goodfellow et al.
7,008,433 B2 3/2006 Voellmicke et al.
7,008,435 B2 3/2006 Cummins
7,009,039 B2 3/2006 Yayon et al.
7,011,657 B2 3/2006 Truckai et al.
7,014,640 B2 3/2006 Kemppainen et al.
7,018,357 B2 3/2006 Emmons
7,018,390 B2 3/2006 Turovskiy et al.
7,021,669 B1 4/2006 Lindermeir et al.
7,022,131 B1 4/2006 Derowe et al.
7,023,159 B2 4/2006 Gorti et al.
7,025,064 B2 4/2006 Wang et al.
7,025,732 B2 4/2006 Thompson et al.
7,025,743 B2 4/2006 Mann et al.
7,025,774 B2 4/2006 Freeman et al.
7,025,775 B2 4/2006 Gadberry et al.
7,028,570 B2 4/2006 Ohta et al.
7,029,435 B2 4/2006 Nakao
7,029,439 B2 4/2006 Roberts et al.
7,030,904 B2 4/2006 Adair et al.
7,032,798 B2 4/2006 Whitman et al.
7,032,799 B2 4/2006 Viola et al.
7,033,356 B2 4/2006 Latterell et al.
7,035,716 B2 4/2006 Harris et al.
7,035,762 B2 4/2006 Menard et al.
7,036,680 B1 5/2006 Flannery
7,037,314 B2 5/2006 Armstrong
7,037,344 B2 5/2006 Kagan et al.
7,041,088 B2 5/2006 Nawrocki et al.
7,041,102 B2 5/2006 Truckai et al.
7,041,868 B2 5/2006 Greene et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,043,852 B2 5/2006 Hayashida et al.
7,044,350 B2 5/2006 Kameyama et al.
7,044,352 B2 5/2006 Shelton, IV et al.
7,044,353 B2 5/2006 Mastri et al.
7,046,082 B2 5/2006 Komiya et al.
7,048,165 B2 5/2006 Haramiishi
7,048,687 B1 5/2006 Reuss et al.
7,048,745 B2 5/2006 Tierney et al.
7,052,454 B2 5/2006 Taylor
7,052,494 B2 5/2006 Goble et al.
7,052,499 B2 5/2006 Steger et al.
7,055,730 B2 6/2006 Ehrenfels et al.
7,055,731 B2 6/2006 Shelton, IV et al.
7,056,284 B2 6/2006 Martone et al.
7,056,330 B2 6/2006 Gayton
7,059,331 B2 6/2006 Adams et al.
7,059,508 B2 6/2006 Shelton, IV et al.
7,063,671 B2 6/2006 Couvillon, Jr.
7,063,712 B2 6/2006 Vargas et al.
7,064,509 B1 6/2006 Fu et al.
7,066,879 B2 6/2006 Fowler et al.
7,066,944 B2 6/2006 Laufer et al.
7,067,038 B2 6/2006 Trokhan et al.
7,070,083 B2 7/2006 Jankowski
7,070,559 B2 7/2006 Adams et al.
7,070,597 B2 7/2006 Truckai et al.
7,071,287 B2 7/2006 Rhine et al.
7,075,770 B1 7/2006 Smith
7,077,856 B2 7/2006 Whitman
7,080,769 B2 7/2006 Vresh et al.
7,081,114 B2 7/2006 Rashidi
7,083,073 B2 8/2006 Yoshie et al.
7,083,075 B2 8/2006 Swayze et al.
7,083,571 B2 8/2006 Wang et al.
7,083,615 B2 8/2006 Peterson et al.
7,083,619 B2 8/2006 Truckai et al.
7,083,620 B2 8/2006 Jahns et al.
7,083,626 B2 8/2006 Hart et al.
7,086,267 B2 8/2006 Dworak et al.
7,087,049 B2 8/2006 Nowlin et al.
7,087,054 B2 8/2006 Truckai et al.
7,087,071 B2 8/2006 Nicholas et al.
7,090,637 B2 8/2006 Danitz et al.
7,090,673 B2 8/2006 Dycus et al.
7,090,683 B2 8/2006 Brock et al.
7,090,684 B2 8/2006 McGuckin, Jr. et al.
7,091,191 B2 8/2006 Laredo et al.
7,091,412 B2 8/2006 Wang et al.
7,093,492 B2 8/2006 Treiber et al.
7,094,202 B2 8/2006 Nobis et al.
7,094,247 B2 8/2006 Monassevitch et al.
7,094,916 B2 8/2006 DeLuca et al.
7,096,972 B2 8/2006 Orozco, Jr.
7,097,089 B2 8/2006 Marczyk
7,097,644 B2 8/2006 Long
7,097,650 B2 8/2006 Weller et al.
7,098,794 B2 8/2006 Lindsay et al.
7,100,949 B2 9/2006 Williams et al.
7,101,187 B1 9/2006 Deconinck et al.
7,101,371 B2 9/2006 Dycus et al.
7,101,394 B2 9/2006 Hamm et al.
7,104,741 B2 9/2006 Krohn
7,108,695 B2 9/2006 Witt et al.
7,108,701 B2 9/2006 Evens et al.
7,108,709 B2 9/2006 Cummins
7,111,768 B2 9/2006 Cummins et al.
7,111,769 B2 9/2006 Wales et al.
7,112,214 B2 9/2006 Peterson et al.
RE39,358 E 10/2006 Goble
7,114,642 B2 10/2006 Whitman
7,116,100 B1 10/2006 Mock et al.
7,118,020 B2 10/2006 Lee et al.
7,118,528 B1 10/2006 Piskun
7,118,563 B2 10/2006 Weckwerth et al.
7,118,582 B1 10/2006 Wang et al.
7,119,534 B2 10/2006 Butzmann
7,121,446 B2 10/2006 Arad et al.
7,121,773 B2 10/2006 Mikiya et al.
7,122,028 B2 10/2006 Looper et al.
7,125,403 B2 10/2006 Julian et al.
7,125,409 B2 10/2006 Truckai et al.
7,126,303 B2 10/2006 Farritor et al.
7,126,879 B2 10/2006 Snyder
7,128,253 B2 10/2006 Mastri et al.
7,128,254 B2 10/2006 Shelton, IV et al.
7,128,748 B2 10/2006 Mooradian et al.
7,131,445 B2 11/2006 Amoah
7,133,601 B2 11/2006 Phillips et al.
7,134,364 B2 11/2006 Kageler et al.
7,134,587 B2 11/2006 Schwemberger et al.
7,135,027 B2 11/2006 Delmotte
7,137,980 B2 11/2006 Buysse et al.
7,137,981 B2 11/2006 Long
7,139,016 B2 11/2006 Squilla et al.
7,140,527 B2 11/2006 Ehrenfels et al.
7,140,528 B2 11/2006 Shelton, IV
7,141,055 B2 11/2006 Abrams et al.
7,143,923 B2 12/2006 Shelton, IV et al.
7,143,924 B2 12/2006 Scirica et al.
7,143,925 B2 12/2006 Shelton, IV et al.
7,143,926 B2 12/2006 Shelton, IV et al.
7,146,191 B2 12/2006 Kerner et al.
7,147,138 B2 12/2006 Shelton, IV
7,147,139 B2 12/2006 Schwemberger et al.
7,147,140 B2 12/2006 Wukusick et al.
7,147,637 B2 12/2006 Goble
7,147,648 B2 12/2006 Lin
7,147,650 B2 12/2006 Lee
7,150,748 B2 12/2006 Ebbutt et al.
7,153,300 B2 12/2006 Goble
7,153,314 B2 12/2006 Laufer et al.
7,155,316 B2 12/2006 Sutherland et al.
7,156,863 B2 1/2007 Sonnenschein et al.
7,159,750 B2 1/2007 Racenet et al.
7,160,296 B2 1/2007 Pearson et al.
7,160,299 B2 1/2007 Baily
7,161,036 B2 1/2007 Oikawa et al.
7,161,580 B2 1/2007 Bailey et al.
7,162,758 B2 1/2007 Skinner
7,163,563 B2 1/2007 Schwartz et al.
7,166,133 B2 1/2007 Evans et al.
7,168,604 B2 1/2007 Milliman et al.
7,170,910 B2 1/2007 Chen et al.
7,171,279 B2 1/2007 Buckingham et al.
7,172,104 B2 2/2007 Scirica et al.
7,172,593 B2 2/2007 Trieu et al.
7,172,615 B2 2/2007 Morriss et al.
7,174,202 B2 2/2007 Bladen et al.
7,174,636 B2 2/2007 Lowe
7,177,533 B2 2/2007 McFarlin et al.
7,179,223 B2 2/2007 Motoki et al.
7,179,267 B2 2/2007 Nolan et al.
7,182,239 B1 2/2007 Myers
7,182,763 B2 2/2007 Nardella
7,183,737 B2 2/2007 Kitagawa
7,187,960 B2 3/2007 Abreu
7,188,758 B2 3/2007 Viola et al.
7,189,207 B2 3/2007 Viola
7,190,147 B2 3/2007 Gileff et al.
7,193,199 B2 3/2007 Jang
7,195,627 B2 3/2007 Amoah et al.
7,196,911 B2 3/2007 Takano et al.
D541,418 S 4/2007 Schechter et al.
7,199,537 B2 4/2007 Okamura et al.
7,202,576 B1 4/2007 Dechene et al.
7,202,653 B2 4/2007 Pai
7,204,404 B2 4/2007 Nguyen et al.
7,204,835 B2 4/2007 Latterell et al.
7,206,626 B2 4/2007 Quaid, III
7,207,233 B2 4/2007 Wadge
7,207,471 B2 4/2007 Heinrich et al.
7,207,472 B2 4/2007 Wukusick et al.
7,207,556 B2 4/2007 Saitoh et al.
7,208,005 B2 4/2007 Frecker et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,210,609 B2 5/2007 Leiboff et al.
7,211,081 B2 5/2007 Goble
7,211,084 B2 5/2007 Goble et al.
7,211,092 B2 5/2007 Hughett
7,211,979 B2 5/2007 Khatib et al.
7,213,736 B2 5/2007 Wales et al.
7,214,224 B2 5/2007 Goble
7,215,517 B2 5/2007 Takamatsu
7,217,285 B2 5/2007 Vargas et al.
7,220,260 B2 5/2007 Fleming et al.
7,220,272 B2 5/2007 Weadock
7,225,959 B2 6/2007 Patton et al.
7,225,963 B2 6/2007 Scirica
7,225,964 B2 6/2007 Mastri et al.
7,226,450 B2 6/2007 Athanasiou et al.
7,228,505 B2 6/2007 Shimazu et al.
7,229,408 B2 6/2007 Douglas et al.
7,234,624 B2 6/2007 Gresham et al.
7,235,072 B2 6/2007 Sartor et al.
7,235,089 B1 6/2007 McGuckin, Jr.
7,235,302 B2 6/2007 Jing et al.
7,237,708 B1 7/2007 Guy et al.
7,238,195 B2 7/2007 Viola
7,238,901 B2 7/2007 Kim et al.
7,239,657 B1 7/2007 Gunnarsson
7,241,288 B2 7/2007 Braun
7,241,289 B2 7/2007 Braun
7,246,734 B2 7/2007 Shelton, IV
7,247,161 B2 7/2007 Johnston et al.
7,249,267 B2 7/2007 Chapuis
7,252,641 B2 8/2007 Thompson et al.
7,252,660 B2 8/2007 Kunz
7,255,012 B2 8/2007 Hedtke
7,255,696 B2 8/2007 Goble et al.
7,256,695 B2 8/2007 Hamel et al.
7,258,262 B2 8/2007 Mastri et al.
7,258,546 B2 8/2007 Beier et al.
7,260,431 B2 8/2007 Libbus et al.
7,265,374 B2 9/2007 Lee et al.
7,267,677 B2 9/2007 Johnson et al.
7,267,679 B2 9/2007 McGuckin, Jr. et al.
7,272,002 B2 9/2007 Drapeau
7,273,483 B2 9/2007 Wiener et al.
D552,623 S 10/2007 Vong et al.
7,275,674 B2 10/2007 Racenet et al.
7,276,044 B2 10/2007 Ferry et al.
7,276,068 B2 10/2007 Johnson et al.
7,278,562 B2 10/2007 Mastri et al.
7,278,563 B1 10/2007 Green
7,278,949 B2 10/2007 Bader
7,278,994 B2 10/2007 Goble
7,282,048 B2 10/2007 Goble et al.
7,283,096 B2 10/2007 Geisheimer et al.
7,286,850 B2 10/2007 Frielink et al.
7,287,682 B1 10/2007 Ezzat et al.
7,289,139 B2 10/2007 Amling et al.
7,293,685 B2 11/2007 Ehrenfels et al.
7,295,893 B2 11/2007 Sunaoshi
7,295,907 B2 11/2007 Lu et al.
7,296,722 B2 11/2007 Ivanko
7,296,724 B2 11/2007 Green et al.
7,297,149 B2 11/2007 Vitali et al.
7,300,373 B2 11/2007 Jinno et al.
7,300,431 B2 11/2007 Dubrovsky
7,300,450 B2 11/2007 Vleugels et al.
7,303,106 B2 12/2007 Milliman et al.
7,303,107 B2 12/2007 Milliman et al.
7,303,108 B2 12/2007 Shelton, IV
7,303,502 B2 12/2007 Thompson
7,303,556 B2 12/2007 Metzger
7,306,597 B2 12/2007 Manzo
7,308,998 B2 12/2007 Mastri et al.
7,311,238 B2 12/2007 Liu
7,313,430 B2 12/2007 Urquhart et al.
7,314,473 B2 1/2008 Jinno et al.
7,322,859 B2 1/2008 Evans
7,322,975 B2 1/2008 Goble et al.
7,322,994 B2 1/2008 Nicholas et al.
7,324,572 B2 1/2008 Chang
7,326,203 B2 2/2008 Papineau et al.
7,326,213 B2 2/2008 Benderev et al.
7,328,828 B2 2/2008 Ortiz et al.
7,328,829 B2 2/2008 Arad et al.
7,330,004 B2 2/2008 DeJonge et al.
7,331,340 B2 2/2008 Barney
7,331,343 B2 2/2008 Schmidt et al.
7,331,403 B2 2/2008 Berry et al.
7,331,406 B2 2/2008 Wottreng, Jr. et al.
7,331,969 B1 2/2008 Inganas et al.
7,334,717 B2 2/2008 Rethy et al.
7,334,718 B2 2/2008 McAlister et al.
7,335,199 B2 2/2008 Goble et al.
7,335,401 B2 2/2008 Finke et al.
7,336,045 B2 2/2008 Clermonts
7,336,048 B2 2/2008 Lohr
7,336,184 B2 2/2008 Smith et al.
7,337,774 B2 3/2008 Webb
7,338,505 B2 3/2008 Belson
7,338,513 B2 3/2008 Lee et al.
7,341,554 B2 3/2008 Sekine et al.
7,341,555 B2 3/2008 Ootawara et al.
7,341,591 B2 3/2008 Grinberg
7,343,920 B2 3/2008 Toby et al.
7,344,532 B2 3/2008 Goble et al.
7,344,533 B2 3/2008 Pearson et al.
7,346,344 B2 3/2008 Fontaine
7,346,406 B2 3/2008 Brotto et al.
7,348,763 B1 3/2008 Reinhart et al.
7,348,875 B2 3/2008 Hughes et al.
RE40,237 E 4/2008 Bilotti et al.
7,351,258 B2 4/2008 Ricotta et al.
7,354,447 B2 4/2008 Shelton, IV et al.
7,354,502 B2 4/2008 Polat et al.
7,357,287 B2 4/2008 Shelton, IV et al.
7,357,806 B2 4/2008 Rivera et al.
7,361,168 B2 4/2008 Makower et al.
7,361,195 B2 4/2008 Schwartz et al.
7,362,062 B2 4/2008 Schneider et al.
7,364,060 B2 4/2008 Milliman
7,364,061 B2 4/2008 Swayze et al.
7,367,485 B2 5/2008 Shelton, IV et al.
7,368,124 B2 5/2008 Chun et al.
7,371,210 B2 5/2008 Brock et al.
7,371,403 B2 5/2008 McCarthy et al.
7,377,918 B2 5/2008 Amoah
7,377,928 B2 5/2008 Zubik et al.
RE40,388 E 6/2008 Gines
7,380,695 B2 6/2008 Doll et al.
7,380,696 B2 6/2008 Shelton, IV et al.
7,384,403 B2 6/2008 Sherman
7,384,417 B2 6/2008 Cucin
7,386,365 B2 6/2008 Nixon
7,386,730 B2 6/2008 Uchikubo
7,388,217 B2 6/2008 Buschbeck et al.
7,388,484 B2 6/2008 Hsu
7,391,173 B2 6/2008 Schena
7,394,190 B2 7/2008 Huang
7,396,356 B2 7/2008 Mollenauer
7,397,364 B2 7/2008 Govari
7,398,707 B2 7/2008 Morley et al.
7,398,907 B2 7/2008 Racenet et al.
7,398,908 B2 7/2008 Holsten et al.
7,400,107 B2 7/2008 Schneider et al.
7,400,752 B2 7/2008 Zacharias
7,401,000 B2 7/2008 Nakamura
7,401,721 B2 7/2008 Holsten et al.
7,404,449 B2 7/2008 Bermingham et al.
7,404,508 B2 7/2008 Smith et al.
7,404,509 B2 7/2008 Ortiz et al.
7,404,822 B2 7/2008 Viart et al.
7,407,074 B2 8/2008 Ortiz et al.
7,407,075 B2 8/2008 Holsten et al.
7,407,076 B2 8/2008 Racenet et al.
7,407,077 B2 8/2008 Ortiz et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,407,078 B2 8/2008 Shelton, IV et al.
7,408,310 B2 8/2008 Hong et al.
7,410,085 B2 8/2008 Wolf et al.
7,410,086 B2 8/2008 Ortiz et al.
7,410,483 B2 8/2008 Danitz et al.
7,413,563 B2 8/2008 Corcoran et al.
7,416,101 B2 8/2008 Shelton, IV et al.
7,418,078 B2 8/2008 Blanz et al.
RE40,514 E 9/2008 Mastri et al.
7,419,080 B2 9/2008 Smith et al.
7,419,081 B2 9/2008 Ehrenfels et al.
7,419,321 B2 9/2008 Tereschouk
7,419,495 B2 9/2008 Menn et al.
7,422,136 B1 9/2008 Marczyk
7,422,138 B2 9/2008 Bilotti et al.
7,422,139 B2 9/2008 Shelton, IV et al.
7,424,965 B2 9/2008 Racenet et al.
7,427,607 B2 9/2008 Suzuki
D578,644 S 10/2008 Shumer et al.
7,430,772 B2 10/2008 Van Es
7,431,188 B1 10/2008 Marczyk
7,431,189 B2 10/2008 Shelton, IV et al.
7,431,230 B2 10/2008 McPherson et al.
7,431,694 B2 10/2008 Stefanchik et al.
7,431,730 B2 10/2008 Viola
7,434,715 B2 10/2008 Shelton, IV et al.
7,434,717 B2 10/2008 Shelton, IV et al.
7,435,249 B2 10/2008 Buysse et al.
7,438,209 B1 10/2008 Hess et al.
7,438,718 B2 10/2008 Milliman et al.
7,439,354 B2 10/2008 Lenges et al.
7,441,684 B2 10/2008 Shelton, IV et al.
7,441,685 B1 10/2008 Boudreaux
7,442,201 B2 10/2008 Pugsley et al.
7,443,547 B2 10/2008 Moreno et al.
7,446,131 B1 11/2008 Liu et al.
7,448,525 B2 11/2008 Shelton, IV et al.
7,450,010 B1 11/2008 Gravelle et al.
7,451,904 B2 11/2008 Shelton, IV
7,455,208 B2 11/2008 Wales et al.
7,455,676 B2 11/2008 Holsten et al.
7,455,682 B2 11/2008 Viola
D582,934 S 12/2008 Byeon
7,461,767 B2 12/2008 Viola et al.
7,462,187 B2 12/2008 Johnston et al.
7,464,845 B2 12/2008 Chou
7,464,846 B2 12/2008 Shelton, IV et al.
7,464,847 B2 12/2008 Viola et al.
7,464,848 B2 12/2008 Green et al.
7,464,849 B2 12/2008 Shelton, IV et al.
7,467,740 B2 12/2008 Shelton, IV et al.
7,467,849 B2 12/2008 Silverbrook et al.
7,472,814 B2 1/2009 Mastri et al.
7,472,815 B2 1/2009 Shelton, IV et al.
7,472,816 B2 1/2009 Holsten et al.
7,473,221 B2 1/2009 Ewers et al.
7,473,253 B2 1/2009 Dycus et al.
7,473,263 B2 1/2009 Johnston et al.
7,476,237 B2 1/2009 Taniguchi et al.
7,479,608 B2 1/2009 Smith
7,481,347 B2 1/2009 Roy
7,481,348 B2 1/2009 Marczyk
7,481,349 B2 1/2009 Holsten et al.
7,481,824 B2 1/2009 Boudreaux et al.
7,485,124 B2 2/2009 Kuhns et al.
7,485,133 B2 2/2009 Cannon et al.
7,485,142 B2 2/2009 Milo
7,487,899 B2 2/2009 Shelton, IV et al.
7,489,055 B2 2/2009 Jeong et al.
7,490,749 B2 2/2009 Schall et al.
7,491,232 B2 2/2009 Bolduc et al.
7,494,039 B2 2/2009 Racenet et al.
7,494,460 B2 2/2009 Haarstad et al.
7,494,499 B2 2/2009 Nagase et al.
7,494,501 B2 2/2009 Ahlberg et al.
7,500,979 B2 3/2009 Hueil et al.
7,501,198 B2 3/2009 Barley et al.
7,503,474 B2 3/2009 Hillstead et al.
7,506,790 B2 3/2009 Shelton, IV
7,506,791 B2 3/2009 Omaits et al.
7,507,202 B2 3/2009 Schoellhorn
7,510,107 B2 3/2009 Timm et al.
7,510,534 B2 3/2009 Burdorff et al.
7,510,566 B2 3/2009 Jacobs et al.
7,513,407 B1 4/2009 Chang
7,513,408 B2 4/2009 Shelton, IV et al.
7,517,356 B2 4/2009 Heinrich
7,524,320 B2 4/2009 Tierney et al.
7,527,632 B2 5/2009 Houghton et al.
7,530,984 B2 5/2009 Sonnenschein et al.
7,530,985 B2 5/2009 Takemoto et al.
7,533,906 B2 5/2009 Luettgen et al.
7,534,259 B2 5/2009 Lashinski et al.
7,540,867 B2 6/2009 Jinno et al.
7,540,872 B2 6/2009 Schechter et al.
7,542,807 B2 6/2009 Bertolero et al.
7,543,730 B1 6/2009 Marczyk
7,546,939 B2 6/2009 Adams et al.
7,546,940 B2 6/2009 Milliman et al.
7,547,287 B2 6/2009 Boecker et al.
7,547,312 B2 6/2009 Bauman et al.
7,549,563 B2 6/2009 Mather et al.
7,549,564 B2 6/2009 Boudreaux
7,549,998 B2 6/2009 Braun
7,552,854 B2 6/2009 Wixey et al.
7,553,173 B2 6/2009 Kowalick
7,553,275 B2 6/2009 Padget et al.
7,554,343 B2 6/2009 Bromfield
7,556,185 B2 7/2009 Viola
7,556,186 B2 7/2009 Milliman
7,556,647 B2 7/2009 Drews et al.
7,559,449 B2 7/2009 Viola
7,559,450 B2 7/2009 Wales et al.
7,559,452 B2 7/2009 Wales et al.
7,559,937 B2 7/2009 de la Torre et al.
7,561,637 B2 7/2009 Jonsson et al.
7,562,910 B2 7/2009 Kertesz et al.
7,563,269 B2 7/2009 Hashiguchi
7,563,862 B2 7/2009 Sieg et al.
7,565,993 B2 7/2009 Milliman et al.
7,566,300 B2 7/2009 Devierre et al.
7,567,045 B2 7/2009 Fristedt
7,568,603 B2 8/2009 Shelton, IV et al.
7,568,604 B2 8/2009 Ehrenfels et al.
7,568,619 B2 8/2009 Todd et al.
7,575,144 B2 8/2009 Ortiz et al.
7,578,825 B2 8/2009 Huebner
D600,712 S 9/2009 LaManna et al.
7,583,063 B2 9/2009 Dooley
7,584,880 B2 9/2009 Racenet et al.
7,586,289 B2 9/2009 Andruk et al.
7,588,174 B2 9/2009 Holsten et al.
7,588,175 B2 9/2009 Timm et al.
7,588,176 B2 9/2009 Timm et al.
7,588,177 B2 9/2009 Racenet
7,591,783 B2 9/2009 Boulais et al.
7,591,818 B2 9/2009 Bertolero et al.
7,593,766 B2 9/2009 Faber et al.
7,597,229 B2 10/2009 Boudreaux et al.
7,597,230 B2 10/2009 Racenet et al.
7,597,693 B2 10/2009 Garrison
7,597,699 B2 10/2009 Rogers
7,598,972 B2 10/2009 Tomita
7,600,663 B2 10/2009 Green
7,604,118 B2 10/2009 Iio et al.
7,604,150 B2 10/2009 Boudreaux
7,604,151 B2 10/2009 Hess et al.
7,604,668 B2 10/2009 Farnsworth et al.
7,607,557 B2 10/2009 Shelton, IV et al.
7,608,091 B2 10/2009 Goldfarb et al.
D604,325 S 11/2009 Ebeling et al.
7,611,038 B2 11/2009 Racenet et al.
7,611,474 B2 11/2009 Hibner et al.
7,615,003 B2 11/2009 Stefanchik et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,615,006 B2 11/2009 Abe
7,615,067 B2 11/2009 Lee et al.
7,617,961 B2 11/2009 Viola
D605,201 S 12/2009 Lorenz et al.
D607,010 S 12/2009 Kocmick
7,624,902 B2 12/2009 Marczyk et al.
7,624,903 B2 12/2009 Green et al.
7,625,370 B2 12/2009 Hart et al.
7,630,841 B2 12/2009 Comisky et al.
7,631,793 B2 12/2009 Rethy et al.
7,631,794 B2 12/2009 Rethy et al.
7,635,074 B2 12/2009 Olson et al.
7,635,922 B2 12/2009 Becker
7,637,409 B2 12/2009 Marczyk
7,637,410 B2 12/2009 Marczyk
7,638,958 B2 12/2009 Philipp et al.
7,641,091 B2 1/2010 Olson et al.
7,641,092 B2 1/2010 Kruszynski et al.
7,641,093 B2 1/2010 Doll et al.
7,641,095 B2 1/2010 Viola
7,641,671 B2 1/2010 Crainich
7,644,783 B2 1/2010 Roberts et al.
7,644,848 B2 1/2010 Swayze et al.
7,645,230 B2 1/2010 Mikkaichi et al.
7,648,055 B2 1/2010 Marczyk
7,648,457 B2 1/2010 Stefanchik et al.
7,648,519 B2 1/2010 Lee et al.
7,650,185 B2 1/2010 Maile et al.
7,651,017 B2 1/2010 Ortiz et al.
7,651,498 B2 1/2010 Shifrin et al.
7,654,431 B2 2/2010 Hueil et al.
7,655,004 B2 2/2010 Long
7,655,288 B2 2/2010 Bauman et al.
7,655,584 B2 2/2010 Biran et al.
7,656,131 B2 2/2010 Embrey et al.
7,658,311 B2 2/2010 Boudreaux
7,658,312 B2 2/2010 Vidal et al.
7,658,705 B2 2/2010 Melvin et al.
7,659,219 B2 2/2010 Biran et al.
7,661,448 B2 2/2010 Kim et al.
7,662,161 B2 2/2010 Briganti et al.
7,665,646 B2 2/2010 Prommersberger
7,665,647 B2 2/2010 Shelton, IV et al.
7,669,746 B2 3/2010 Shelton, IV
7,669,747 B2 3/2010 Weisenburgh, II et al.
7,670,334 B2 3/2010 Hueil et al.
7,673,780 B2 3/2010 Shelton, IV et al.
7,673,781 B2 3/2010 Swayze et al.
7,673,782 B2 3/2010 Hess et al.
7,673,783 B2 3/2010 Morgan et al.
7,674,253 B2 3/2010 Fisher et al.
7,674,255 B2 3/2010 Braun
7,674,263 B2 3/2010 Ryan
7,674,270 B2 3/2010 Layer
7,682,307 B2 3/2010 Danitz et al.
7,682,367 B2 3/2010 Shah et al.
7,682,686 B2 3/2010 Curro et al.
7,686,201 B2 3/2010 Csiky
7,686,804 B2 3/2010 Johnson et al.
7,686,826 B2 3/2010 Lee et al.
7,688,028 B2 3/2010 Phillips et al.
7,691,098 B2 4/2010 Wallace et al.
7,691,103 B2 4/2010 Fernandez et al.
7,691,106 B2 4/2010 Schenberger et al.
7,694,864 B2 4/2010 Okada et al.
7,694,865 B2 4/2010 Scirica
7,695,485 B2 4/2010 Whitman et al.
7,695,493 B2 4/2010 Saadat et al.
7,699,204 B2 4/2010 Viola
7,699,835 B2 4/2010 Lee et al.
7,699,844 B2 4/2010 Utley et al.
7,699,846 B2 4/2010 Ryan
7,699,856 B2 4/2010 Van Wyk et al.
7,699,859 B2 4/2010 Bombard et al.
7,699,860 B2 4/2010 Huitema et al.
7,699,868 B2 4/2010 Frank et al.
7,703,653 B2 4/2010 Shah et al.
7,705,559 B2 4/2010 Powell et al.
7,708,180 B2 5/2010 Murray et al.
7,708,181 B2 5/2010 Cole et al.
7,708,182 B2 5/2010 Viola
7,708,758 B2 5/2010 Lee et al.
7,712,182 B2 5/2010 Zeiler et al.
7,713,190 B2 5/2010 Brock et al.
7,713,542 B2 5/2010 Xu et al.
7,714,239 B2 5/2010 Smith
7,714,334 B2 5/2010 Lin
7,717,312 B2 5/2010 Beetel
7,717,313 B2 5/2010 Criscuolo et al.
7,717,846 B2 5/2010 Zirps et al.
7,717,873 B2 5/2010 Swick
7,717,915 B2 5/2010 Miyazawa
7,717,926 B2 5/2010 Whitfield et al.
7,718,180 B2 5/2010 Karp
7,718,556 B2 5/2010 Matsuda et al.
7,721,930 B2 5/2010 McKenna et al.
7,721,931 B2 5/2010 Shelton, IV et al.
7,721,933 B2 5/2010 Ehrenfels et al.
7,721,934 B2 5/2010 Shelton, IV et al.
7,721,936 B2 5/2010 Shalton, IV et al.
7,722,527 B2 5/2010 Bouchier et al.
7,722,607 B2 5/2010 Dumbauld et al.
7,722,610 B2 5/2010 Viola et al.
7,725,214 B2 5/2010 Diolaiti
7,726,171 B2 6/2010 Langlotz et al.
7,726,537 B2 6/2010 Olson et al.
7,726,538 B2 6/2010 Holsten et al.
7,726,539 B2 6/2010 Holsten et al.
7,727,954 B2 6/2010 McKay
7,728,553 B2 6/2010 Carrier et al.
7,729,742 B2 6/2010 Govari
7,731,072 B2 6/2010 Timm et al.
7,731,073 B2 6/2010 Wixey et al.
7,731,724 B2 6/2010 Huitema et al.
7,735,703 B2 6/2010 Morgan et al.
7,736,254 B2 6/2010 Schena
7,736,306 B2 6/2010 Brustad et al.
7,736,374 B2 6/2010 Vaughan et al.
7,738,971 B2 6/2010 Swayze et al.
7,740,159 B2 6/2010 Shelton, IV et al.
7,742,036 B2 6/2010 Grant et al.
7,743,960 B2 6/2010 Whitman et al.
7,744,624 B2 6/2010 Bettuchi
7,744,627 B2 6/2010 Orban, III et al.
7,744,628 B2 6/2010 Viola
7,747,146 B2 6/2010 Milano et al.
7,748,587 B2 7/2010 Haramiishi et al.
7,748,632 B2 7/2010 Coleman et al.
7,749,204 B2 7/2010 Dhanaraj et al.
7,751,870 B2 7/2010 Whitman
7,753,245 B2 7/2010 Boudreaux et al.
7,753,246 B2 7/2010 Scirica
7,753,904 B2 7/2010 Shelton, IV et al.
7,757,924 B2 7/2010 Gerbi et al.
7,758,594 B2 7/2010 Lamson et al.
7,758,612 B2 7/2010 Shipp
7,762,462 B2 7/2010 Gelbman
7,762,998 B2 7/2010 Birk et al.
7,766,207 B2 8/2010 Mather et al.
7,766,209 B2 8/2010 Baxter, III et al.
7,766,210 B2 8/2010 Shelton, IV et al.
7,766,821 B2 8/2010 Brunnen et al.
7,766,894 B2 8/2010 Weitzner et al.
7,770,658 B2 8/2010 Ito et al.
7,770,773 B2 8/2010 Whitman et al.
7,770,774 B2 8/2010 Mastri et al.
7,770,775 B2 8/2010 Shelton, IV et al.
7,770,776 B2 8/2010 Chen et al.
7,771,396 B2 8/2010 Stefanchik et al.
7,772,720 B2 8/2010 McGee et al.
7,772,725 B2 8/2010 Siman-Tov
7,775,972 B2 8/2010 Brock et al.
7,776,037 B2 8/2010 Odom
7,776,060 B2 8/2010 Mooradian et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,776,065 B2 8/2010 Griffiths et al.
7,778,004 B2 8/2010 Nerheim et al.
7,779,737 B2 8/2010 Newman, Jr. et al.
7,780,054 B2 8/2010 Wales
7,780,055 B2 8/2010 Scirica et al.
7,780,309 B2 8/2010 McMillan et al.
7,780,663 B2 8/2010 Yates et al.
7,780,685 B2 8/2010 Hunt et al.
7,784,662 B2 8/2010 Wales et al.
7,784,663 B2 8/2010 Shelton, IV
7,787,256 B2 8/2010 Chan et al.
7,789,283 B2 9/2010 Shah
7,789,875 B2 9/2010 Brock et al.
7,789,883 B2 9/2010 Takashino et al.
7,789,889 B2 9/2010 Zubik et al.
7,793,812 B2 9/2010 Moore et al.
7,794,475 B2 9/2010 Hess et al.
7,798,386 B2 9/2010 Schall et al.
7,799,039 B2 9/2010 Shelton, IV et al.
7,799,044 B2 9/2010 Johnston et al.
7,799,965 B2 9/2010 Patel et al.
7,803,151 B2 9/2010 Whitman
7,806,871 B2 10/2010 Li et al.
7,806,891 B2 10/2010 Nowlin et al.
7,810,690 B2 10/2010 Bilotti et al.
7,810,691 B2 10/2010 Boyden et al.
7,810,692 B2 10/2010 Hall et al.
7,810,693 B2 10/2010 Broehl et al.
7,811,275 B2 10/2010 Birk et al.
7,814,816 B2 10/2010 Alberti et al.
7,815,092 B2 10/2010 Whitman et al.
7,815,565 B2 10/2010 Stefanchik et al.
7,815,662 B2 10/2010 Spivey et al.
7,819,296 B2 10/2010 Hueil et al.
7,819,297 B2 10/2010 Doll et al.
7,819,298 B2 10/2010 Hall et al.
7,819,299 B2 10/2010 Shelton, IV et al.
7,819,799 B2 10/2010 Merril et al.
7,819,884 B2 10/2010 Lee et al.
7,819,886 B2 10/2010 Whitfield et al.
7,823,592 B2 11/2010 Bettuchi et al.
7,823,760 B2 11/2010 Zemlok et al.
7,824,401 B2 11/2010 Manzo et al.
7,824,422 B2 11/2010 Benchetrit
7,824,426 B2 11/2010 Racenet et al.
7,828,189 B2 11/2010 Holsten et al.
7,828,794 B2 11/2010 Sartor
7,828,808 B2 11/2010 Hinman et al.
7,831,292 B2 11/2010 Quaid et al.
7,832,408 B2 11/2010 Shelton, IV et al.
7,832,611 B2 11/2010 Boyden et al.
7,832,612 B2 11/2010 Baxter, III et al.
7,833,234 B2 11/2010 Bailly et al.
7,835,823 B2 11/2010 Sillman et al.
7,836,400 B2 11/2010 May et al.
7,837,079 B2 11/2010 Holsten et al.
7,837,080 B2 11/2010 Schwemberger
7,837,081 B2 11/2010 Holsten et al.
7,837,425 B2 11/2010 Saeki et al.
7,837,685 B2 11/2010 Weinberg et al.
7,837,687 B2 11/2010 Harp
7,837,694 B2 11/2010 Tethrake et al.
7,838,789 B2 11/2010 Stoffers et al.
7,839,109 B2 11/2010 Carmen, Jr. et al.
7,841,503 B2 11/2010 Sonnenschein et al.
7,842,025 B2 11/2010 Coleman et al.
7,842,028 B2 11/2010 Lee
7,843,158 B2 11/2010 Prisco
7,845,533 B2 12/2010 Marczyk et al.
7,845,534 B2 12/2010 Viola et al.
7,845,535 B2 12/2010 Scircia
7,845,536 B2 12/2010 Viola et al.
7,845,537 B2 12/2010 Shelton, IV et al.
7,846,085 B2 12/2010 Silverman et al.
7,846,149 B2 12/2010 Jankowski
7,848,066 B2 12/2010 Yanagishima
7,850,623 B2 12/2010 Griffin et al.
7,850,642 B2 12/2010 Moll et al.
7,850,982 B2 12/2010 Stopek et al.
7,854,735 B2 12/2010 Houser et al.
7,854,736 B2 12/2010 Ryan
7,857,183 B2 12/2010 Shelton, IV
7,857,184 B2 12/2010 Viola
7,857,185 B2 12/2010 Swayze et al.
7,857,186 B2 12/2010 Baxter, III et al.
7,857,813 B2 12/2010 Schmitz et al.
7,861,906 B2 1/2011 Doll et al.
7,862,502 B2 1/2011 Pool et al.
7,862,546 B2 1/2011 Conlon et al.
7,862,579 B2 1/2011 Ortiz et al.
7,866,525 B2 1/2011 Scirica
7,866,527 B2 1/2011 Hall et al.
7,866,528 B2 1/2011 Olson et al.
7,870,989 B2 1/2011 Viola et al.
7,871,418 B2 1/2011 Thompson et al.
7,871,440 B2 1/2011 Schwartz et al.
7,875,055 B2 1/2011 Cichocki, Jr.
7,879,063 B2 2/2011 Khosravi
7,879,070 B2 2/2011 Ortiz et al.
7,883,461 B2 2/2011 Albrecht et al.
7,883,465 B2 2/2011 Donofrio et al.
7,886,951 B2 2/2011 Hessler
7,886,952 B2 2/2011 Scirica et al.
7,887,530 B2 2/2011 Zemlok et al.
7,887,535 B2 2/2011 Lands et al.
7,887,536 B2 2/2011 Johnson et al.
7,887,563 B2 2/2011 Cummins
7,891,531 B1 2/2011 Ward
7,891,532 B2 2/2011 Mastri et al.
7,892,200 B2 2/2011 Birk et al.
7,892,245 B2 2/2011 Liddicoat et al.
7,893,586 B2 2/2011 West et al.
7,896,214 B2 3/2011 Farascioni
7,896,215 B2 3/2011 Adams et al.
7,896,869 B2 3/2011 DiSilvestro et al.
7,896,877 B2 3/2011 Hall et al.
7,896,895 B2 3/2011 Boudreaux et al.
7,896,897 B2 3/2011 Gresham et al.
7,898,198 B2 3/2011 Murphree
7,900,805 B2 3/2011 Shelton, IV et al.
7,900,806 B2 3/2011 Chen et al.
7,901,381 B2 3/2011 Birk et al.
7,905,380 B2 3/2011 Shelton, IV et al.
7,905,381 B2 3/2011 Baxter, III et al.
7,905,881 B2 3/2011 Masuda et al.
7,905,889 B2 3/2011 Catanese, III et al.
7,905,890 B2 3/2011 Whitfield et al.
7,905,902 B2 3/2011 Huitema et al.
7,909,039 B2 3/2011 Hur
7,909,191 B2 3/2011 Baker et al.
7,909,220 B2 3/2011 Viola
7,909,221 B2 3/2011 Viola et al.
7,909,224 B2 3/2011 Prommersberger
7,913,891 B2 3/2011 Doll et al.
7,913,893 B2 3/2011 Mastri et al.
7,914,521 B2 3/2011 Wang et al.
7,914,543 B2 3/2011 Roth et al.
7,914,551 B2 3/2011 Ortiz et al.
7,918,230 B2 4/2011 Whitman et al.
7,918,376 B1 4/2011 Knodel et al.
7,918,377 B2 4/2011 Measamer et al.
7,918,845 B2 4/2011 Saadat et al.
7,918,848 B2 4/2011 Lau et al.
7,918,861 B2 4/2011 Brock et al.
7,918,867 B2 4/2011 Dana et al.
7,922,061 B2 4/2011 Shelton, IV et al.
7,922,063 B2 4/2011 Zemlok et al.
7,922,743 B2 4/2011 Heinrich et al.
7,923,144 B2 4/2011 Kohn et al.
7,926,691 B2 4/2011 Viola et al.
7,927,328 B2 4/2011 Orszulak et al.
7,928,281 B2 4/2011 Augustine
7,930,040 B1 4/2011 Kelsch et al.
7,930,065 B2 4/2011 Larkin et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,931,660 B2 4/2011 Aranyi et al.
7,931,695 B2 4/2011 Ringeisen
7,931,877 B2 4/2011 Steffens et al.
7,934,630 B2 5/2011 Shelton, IV et al.
7,934,631 B2 5/2011 Balbierz et al.
7,934,896 B2 5/2011 Schnier
7,935,130 B2 5/2011 Williams
7,935,773 B2 5/2011 Hadba et al.
7,936,142 B2 5/2011 Otsuka et al.
7,938,307 B2 5/2011 Bettuchi
7,941,865 B2 5/2011 Seman, Jr. et al.
7,942,303 B2 5/2011 Shah
7,942,890 B2 5/2011 D'Agostino et al.
7,944,175 B2 5/2011 Mori et al.
7,945,792 B2 5/2011 Cherpantier
7,945,798 B2 5/2011 Carlson et al.
7,946,453 B2 5/2011 Voegele et al.
7,947,011 B2 5/2011 Birk et al.
7,950,560 B2 5/2011 Zemlok et al.
7,950,561 B2 5/2011 Aranyi
7,951,071 B2 5/2011 Whitman et al.
7,951,166 B2 5/2011 Orban, III et al.
7,954,682 B2 6/2011 Giordano et al.
7,954,684 B2 6/2011 Boudreaux
7,954,685 B2 6/2011 Viola
7,954,686 B2 6/2011 Baxter, III et al.
7,954,687 B2 6/2011 Zemlok et al.
7,955,253 B2 6/2011 Ewers et al.
7,955,257 B2 6/2011 Frasier et al.
7,955,322 B2 6/2011 Devengenzo et al.
7,955,327 B2 6/2011 Sartor et al.
7,955,380 B2 6/2011 Chu et al.
7,959,050 B2 6/2011 Smith et al.
7,959,051 B2 6/2011 Smith et al.
7,959,052 B2 6/2011 Sonnenschein et al.
7,963,432 B2 6/2011 Knodel et al.
7,963,433 B2 6/2011 Whitman et al.
7,963,913 B2 6/2011 Devengenzo et al.
7,963,963 B2 6/2011 Francischelli et al.
7,963,964 B2 6/2011 Santilli et al.
7,964,206 B2 6/2011 Suokas et al.
7,966,236 B2 6/2011 Noriega et al.
7,966,269 B2 6/2011 Bauer et al.
7,966,799 B2 6/2011 Morgan et al.
7,967,178 B2 6/2011 Scirica et al.
7,967,179 B2 6/2011 Olson et al.
7,967,180 B2 6/2011 Scirica
7,967,181 B2 6/2011 Viola et al.
7,967,791 B2 6/2011 Franer et al.
7,967,839 B2 6/2011 Flock et al.
7,972,298 B2 7/2011 Wallace et al.
7,972,315 B2 7/2011 Birk et al.
7,976,213 B2 7/2011 Bertolotti et al.
7,976,563 B2 7/2011 Summerer
7,979,137 B2 7/2011 Tracey et al.
7,980,443 B2 7/2011 Scheib et al.
7,981,132 B2 7/2011 Dubrul et al.
7,987,405 B2 7/2011 Turner et al.
7,988,015 B2 8/2011 Mason, II et al.
7,988,026 B2 8/2011 Knodel et al.
7,988,027 B2 8/2011 Olson et al.
7,988,028 B2 8/2011 Farascioni et al.
7,988,779 B2 8/2011 Disalvo et al.
7,992,757 B2 8/2011 Wheeler et al.
7,993,360 B2 8/2011 Hacker et al.
7,994,670 B2 8/2011 Ji
7,997,054 B2 8/2011 Bertsch et al.
7,997,468 B2 8/2011 Farascioni
7,997,469 B2 8/2011 Olson et al.
8,002,696 B2 8/2011 Suzuki
8,002,784 B2 8/2011 Jinno et al.
8,002,785 B2 8/2011 Weiss et al.
8,002,795 B2 8/2011 Beetel
8,006,365 B2 8/2011 Levin et al.
8,006,885 B2 8/2011 Marczyk
8,006,889 B2 8/2011 Adams et al.
8,007,370 B2 8/2011 Hirsch et al.
8,007,465 B2 8/2011 Birk et al.
8,007,479 B2 8/2011 Birk et al.
8,007,511 B2 8/2011 Brock et al.
8,007,513 B2 8/2011 Nalagatla et al.
8,008,598 B2 8/2011 Whitman et al.
8,011,550 B2 9/2011 Aranyi et al.
8,011,551 B2 9/2011 Marczyk et al.
8,011,553 B2 9/2011 Mastri et al.
8,011,555 B2 9/2011 Tarinelli et al.
8,012,170 B2 9/2011 Whitman et al.
8,016,176 B2 9/2011 Kasvikis et al.
8,016,177 B2 9/2011 Bettuchi et al.
8,016,178 B2 9/2011 Olson et al.
8,016,849 B2 9/2011 Wenchell
8,016,855 B2 9/2011 Whitman et al.
8,016,858 B2 9/2011 Whitman
8,016,881 B2 9/2011 Furst
8,020,742 B2 9/2011 Marczyk
8,020,743 B2 9/2011 Shelton, IV
8,021,375 B2 9/2011 Aldrich et al.
8,025,199 B2 9/2011 Whitman et al.
8,025,896 B2 9/2011 Malaviya et al.
8,028,882 B2 10/2011 Viola
8,028,883 B2 10/2011 Stopek
8,028,884 B2 10/2011 Sniffin et al.
8,028,885 B2 10/2011 Smith et al.
8,029,510 B2 10/2011 Hoegerle
8,031,069 B2 10/2011 Cohn et al.
8,033,438 B2 10/2011 Scirica
8,033,439 B2 10/2011 Racenet et al.
8,033,440 B2 10/2011 Wenchell et al.
8,034,077 B2 10/2011 Smith et al.
8,034,337 B2 10/2011 Simard
8,034,363 B2 10/2011 Li et al.
8,035,487 B2 10/2011 Malackowski
8,037,591 B2 10/2011 Spivey et al.
8,038,045 B2 10/2011 Bettuchi et al.
8,038,046 B2 10/2011 Smith et al.
8,038,686 B2 10/2011 Huitema et al.
8,043,207 B2 10/2011 Adams
8,043,328 B2 10/2011 Hahnen et al.
8,044,536 B2 10/2011 Nguyen et al.
8,044,604 B2 10/2011 Hagino et al.
8,047,236 B2 11/2011 Perry
8,048,503 B2 11/2011 Farnsworth et al.
8,052,636 B2 11/2011 Moll et al.
8,056,787 B2 11/2011 Boudreaux et al.
8,056,788 B2 11/2011 Mastri et al.
8,056,789 B1 11/2011 White et al.
8,057,508 B2 11/2011 Shelton, IV
8,058,771 B2 11/2011 Giordano et al.
8,060,250 B2 11/2011 Reiland et al.
8,061,014 B2 11/2011 Smith et al.
8,061,576 B2 11/2011 Cappola
8,062,236 B2 11/2011 Soltz
8,062,330 B2 11/2011 Prommersberger et al.
8,063,619 B2 11/2011 Zhu et al.
8,066,158 B2 11/2011 Vogel et al.
8,066,166 B2 11/2011 Demmy et al.
8,066,167 B2 11/2011 Measamer et al.
8,066,168 B2 11/2011 Vidal et al.
8,066,720 B2 11/2011 Knodel et al.
D650,074 S 12/2011 Hunt et al.
D650,789 S 12/2011 Arnold
8,070,033 B2 12/2011 Milliman et al.
8,070,034 B1 12/2011 Knodel
8,070,035 B2 12/2011 Holsten et al.
8,070,743 B2 12/2011 Kagan et al.
8,074,858 B2 12/2011 Marczyk
8,074,861 B2 12/2011 Ehrenfels et al.
8,075,476 B2 12/2011 Vargas
8,075,571 B2 12/2011 Vitali et al.
8,079,950 B2 12/2011 Stern et al.
8,079,989 B2 12/2011 Birk et al.
8,080,004 B2 12/2011 Downey et al.
8,083,118 B2 12/2011 Milliman et al.
8,083,119 B2 12/2011 Prommersberger

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,083,120 B2 12/2011 Shelton, IV et al.
8,084,001 B2 12/2011 Burns et al.
8,084,969 B2 12/2011 David et al.
8,085,013 B2 12/2011 Wei et al.
8,087,562 B1 1/2012 Manoux et al.
8,087,563 B2 1/2012 Milliman et al.
8,089,509 B2 1/2012 Chatenever et al.
8,091,753 B2 1/2012 Viola
8,091,756 B2 1/2012 Viola
8,092,443 B2 1/2012 Bischoff
8,092,932 B2 1/2012 Phillips et al.
8,093,572 B2 1/2012 Kuduvalli
8,096,458 B2 1/2012 Hessler
8,096,459 B2 1/2012 Ortiz et al.
8,097,017 B2 1/2012 Viola
8,100,310 B2 1/2012 Zemlok
8,100,824 B2 1/2012 Hegeman et al.
8,100,872 B2 1/2012 Patel
8,102,138 B2 1/2012 Sekine et al.
8,102,278 B2 1/2012 Deck et al.
8,105,350 B2 1/2012 Lee et al.
8,107,925 B2 1/2012 Natsuno et al.
8,108,033 B2 1/2012 Drew et al.
8,108,072 B2 1/2012 Zhao et al.
8,109,426 B2 2/2012 Milliman et al.
8,110,208 B1 2/2012 Hen
8,113,405 B2 2/2012 Milliman
8,113,407 B2 2/2012 Holsten et al.
8,113,408 B2 2/2012 Wenchell et al.
8,113,410 B2 2/2012 Hall et al.
8,114,017 B2 2/2012 Bacher
8,114,100 B2 2/2012 Smith et al.
8,118,206 B2 2/2012 Zand et al.
8,118,207 B2 2/2012 Racenet et al.
8,120,301 B2 2/2012 Goldberg et al.
8,122,128 B2 2/2012 Burke, II et al.
8,123,103 B2 2/2012 Milliman
8,123,523 B2 2/2012 Carron et al.
8,123,766 B2 2/2012 Bauman et al.
8,123,767 B2 2/2012 Bauman et al.
8,125,168 B2 2/2012 Johnson et al.
8,127,975 B2 3/2012 Olson et al.
8,127,976 B2 3/2012 Scirica et al.
8,128,624 B2 3/2012 Couture et al.
8,128,643 B2 3/2012 Aranyi et al.
8,128,645 B2 3/2012 Sonnenschein et al.
8,128,662 B2 3/2012 Altarac et al.
8,132,703 B2 3/2012 Milliman et al.
8,132,705 B2 3/2012 Viola et al.
8,132,706 B2 3/2012 Marczyk et al.
8,133,500 B2 3/2012 Ringeisen et al.
8,134,306 B2 3/2012 Drader et al.
8,136,711 B2 3/2012 Beardsley et al.
8,136,712 B2 3/2012 Zingman
8,136,713 B2 3/2012 Hathaway et al.
8,137,339 B2 3/2012 Jinno et al.
8,140,417 B2 3/2012 Shibata
8,141,762 B2 3/2012 Bedi et al.
8,141,763 B2 3/2012 Milliman
8,142,200 B2 3/2012 Crunkilton et al.
8,142,425 B2 3/2012 Eggers
8,142,461 B2 3/2012 Houser et al.
8,142,515 B2 3/2012 Therin et al.
8,143,520 B2 3/2012 Cutler
8,146,790 B2 4/2012 Milliman
8,147,421 B2 4/2012 Farquhar et al.
8,147,456 B2 4/2012 Fisher et al.
8,147,485 B2 4/2012 Wham et al.
8,152,041 B2 4/2012 Kostrzewski
8,152,756 B2 4/2012 Webster et al.
8,154,239 B2 4/2012 Katsuki et al.
8,157,145 B2 4/2012 Shelton, IV et al.
8,157,148 B2 4/2012 Scirica
8,157,151 B2 4/2012 Ingmanson et al.
8,157,152 B2 4/2012 Holsten et al.
8,157,153 B2 4/2012 Shelton, IV et al.
8,157,793 B2 4/2012 Omori et al.
8,161,977 B2 4/2012 Shelton, IV et al.
8,162,138 B2 4/2012 Bettenhausen et al.
8,162,197 B2 4/2012 Mastri et al.
8,162,668 B2 4/2012 Toly
8,162,933 B2 4/2012 Francischelli et al.
8,162,965 B2 4/2012 Reschke et al.
8,167,185 B2 5/2012 Shelton, IV et al.
8,167,622 B2 5/2012 Zhou
8,167,895 B2 5/2012 D'Agostino et al.
8,167,898 B1 5/2012 Schaller et al.
8,170,241 B2 5/2012 Roe et al.
8,172,004 B2 5/2012 Ho
8,172,120 B2 5/2012 Boyden et al.
8,172,122 B2 5/2012 Kasvikis et al.
8,172,124 B2 5/2012 Shelton, IV et al.
8,177,776 B2 5/2012 Humayun et al.
8,177,797 B2 5/2012 Shimoji et al.
8,179,705 B2 5/2012 Chapuis
8,180,458 B2 5/2012 Kane et al.
8,181,839 B2 5/2012 Beetel
8,181,840 B2 5/2012 Milliman
8,182,422 B2 5/2012 Bayer et al.
8,182,444 B2 5/2012 Uber, III et al.
8,183,807 B2 5/2012 Tsai et al.
8,186,555 B2 5/2012 Shelton, IV et al.
8,186,556 B2 5/2012 Viola
8,186,558 B2 5/2012 Sapienza
8,186,560 B2 5/2012 Hess et al.
8,191,752 B2 6/2012 Scirica
8,192,350 B2 6/2012 Ortiz et al.
8,192,460 B2 6/2012 Orban, III et al.
8,192,651 B2 6/2012 Young et al.
8,193,129 B2 6/2012 Tagawa et al.
8,196,795 B2 6/2012 Moore et al.
8,196,796 B2 6/2012 Shelton, IV et al.
8,197,501 B2 6/2012 Shadeck et al.
8,197,502 B2 6/2012 Smith et al.
8,197,837 B2 6/2012 Jamiolkowski et al.
8,201,720 B2 6/2012 Hessler
8,201,721 B2 6/2012 Zemlok et al.
8,202,549 B2 6/2012 Stucky et al.
8,205,779 B2 6/2012 Ma et al.
8,205,780 B2 6/2012 Sorrentino et al.
8,205,781 B2 6/2012 Baxter, III et al.
8,210,411 B2 7/2012 Yates et al.
8,210,414 B2 7/2012 Bettuchi et al.
8,210,415 B2 7/2012 Ward
8,210,416 B2 7/2012 Milliman et al.
8,210,721 B2 7/2012 Chen et al.
8,211,125 B2 7/2012 Spivey
8,214,019 B2 7/2012 Govari et al.
8,215,531 B2 7/2012 Shelton, IV et al.
8,215,532 B2 7/2012 Marczyk
8,215,533 B2 7/2012 Viola et al.
8,220,468 B2 7/2012 Cooper et al.
8,220,688 B2 7/2012 Laurent et al.
8,220,690 B2 7/2012 Hess et al.
8,221,402 B2 7/2012 Francischelli et al.
8,221,424 B2 7/2012 Cha
8,221,433 B2 7/2012 Lozier et al.
8,225,799 B2 7/2012 Bettuchi
8,225,979 B2 7/2012 Farascioni et al.
8,226,553 B2 7/2012 Shelton, IV et al.
8,226,635 B2 7/2012 Petrie et al.
8,226,675 B2 7/2012 Houser et al.
8,226,715 B2 7/2012 Hwang et al.
8,227,946 B2 7/2012 Kim
8,228,020 B2 7/2012 Shin et al.
8,228,048 B2 7/2012 Spencer
8,229,549 B2 7/2012 Whitman et al.
8,231,040 B2 7/2012 Zemlok et al.
8,231,042 B2 7/2012 Hessler et al.
8,231,043 B2 7/2012 Tarinelli et al.
8,235,272 B2 8/2012 Nicholas et al.
8,236,010 B2 8/2012 Ortiz et al.
8,236,011 B2 8/2012 Harris et al.
8,236,020 B2 8/2012 Smith et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,237,388 B2 8/2012 Jinno et al.
8,240,537 B2 8/2012 Marczyk
8,241,271 B2 8/2012 Millman et al.
8,241,284 B2 8/2012 Dycus et al.
8,241,308 B2 8/2012 Kortenbach et al.
8,241,322 B2 8/2012 Whitman et al.
8,245,594 B2 8/2012 Rogers et al.
8,245,898 B2 8/2012 Smith et al.
8,245,899 B2 8/2012 Swensgard et al.
8,245,900 B2 8/2012 Scirica
8,245,901 B2 8/2012 Stopek
8,246,608 B2 8/2012 Omori et al.
8,246,637 B2 8/2012 Viola et al.
8,252,009 B2 8/2012 Weller et al.
8,256,654 B2 9/2012 Bettuchi et al.
8,256,655 B2 9/2012 Sniffin et al.
8,256,656 B2 9/2012 Milliman et al.
8,257,251 B2 9/2012 Shelton, IV et al.
8,257,356 B2 9/2012 Bleich et al.
8,257,386 B2 9/2012 Lee et al.
8,257,391 B2 9/2012 Orban, III et al.
8,257,634 B2 9/2012 Scirica
8,258,745 B2 9/2012 Smith et al.
8,261,958 B1 9/2012 Knodel
8,262,560 B2 9/2012 Whitman
8,262,655 B2 9/2012 Ghabrial et al.
8,267,300 B2 9/2012 Boudreaux
8,267,924 B2 9/2012 Zemlok et al.
8,267,946 B2 9/2012 Whitfield et al.
8,267,951 B2 9/2012 Whayne et al.
8,269,121 B2 9/2012 Smith
8,272,553 B2 9/2012 Mastri et al.
8,272,554 B2 9/2012 Whitman et al.
8,272,918 B2 9/2012 Lam
8,273,404 B2 9/2012 Dave et al.
8,276,801 B2 10/2012 Zemlok et al.
8,276,802 B2 10/2012 Kostrzewski
8,277,473 B2 10/2012 Sunaoshi et al.
8,281,446 B2 10/2012 Moskovich
8,281,973 B2 10/2012 Wenchell et al.
8,281,974 B2 10/2012 Hessler et al.
8,282,654 B2 10/2012 Ferrari et al.
8,285,367 B2 10/2012 Hyde et al.
8,286,723 B2 10/2012 Puzio et al.
8,286,845 B2 10/2012 Perry et al.
8,286,846 B2 10/2012 Smith et al.
8,286,847 B2 10/2012 Taylor
8,287,487 B2 10/2012 Estes
8,287,522 B2 10/2012 Moses et al.
8,287,561 B2 10/2012 Nunez et al.
8,288,984 B2 10/2012 Yang
8,289,403 B2 10/2012 Dobashi et al.
8,292,147 B2 10/2012 Viola
8,292,148 B2 10/2012 Viola
8,292,150 B2 10/2012 Bryant
8,292,151 B2 10/2012 Viola
8,292,152 B2 10/2012 Milliman et al.
8,292,155 B2 10/2012 Shelton, IV et al.
8,292,157 B2 10/2012 Smith et al.
8,292,158 B2 10/2012 Sapienza
8,292,801 B2 10/2012 Dejima et al.
8,292,888 B2 10/2012 Whitman
8,294,399 B2 10/2012 Suzuki et al.
8,298,161 B2 10/2012 Vargas
8,298,189 B2 10/2012 Fisher et al.
8,298,233 B2 10/2012 Mueller
8,298,677 B2 10/2012 Wiesner et al.
8,302,323 B2 11/2012 Fortier et al.
8,308,040 B2 11/2012 Huang et al.
8,308,041 B2 11/2012 Kostrzewski
8,308,042 B2 11/2012 Aranyi
8,308,043 B2 11/2012 Bindra et al.
8,308,046 B2 11/2012 Prommersberger
8,308,659 B2 11/2012 Scheibe et al.
8,308,725 B2 11/2012 Bell et al.
8,310,188 B2 11/2012 Nakai
8,313,496 B2 11/2012 Sauer et al.
8,313,499 B2 11/2012 Magnusson et al.
8,313,509 B2 11/2012 Kostrzewski
8,317,070 B2 11/2012 Hueil et al.
8,317,071 B1 11/2012 Knodel
8,317,074 B2 11/2012 Ortiz et al.
8,317,437 B2 11/2012 Merkley et al.
8,317,744 B2 11/2012 Kirschenman
8,317,790 B2 11/2012 Bell et al.
8,319,002 B2 11/2012 Daniels et al.
8,322,455 B2 12/2012 Shelton, IV et al.
8,322,589 B2 12/2012 Boudreaux
8,322,590 B2 12/2012 Patel et al.
8,322,901 B2 12/2012 Michelotti
8,323,789 B2 12/2012 Rozhin et al.
8,328,061 B2 12/2012 Kasvikis
8,328,062 B2 12/2012 Viola
8,328,063 B2 12/2012 Milliman et al.
8,328,064 B2 12/2012 Racenet et al.
8,328,802 B2 12/2012 Deville et al.
8,328,823 B2 12/2012 Aranyi et al.
8,333,313 B2 12/2012 Boudreaux et al.
8,333,691 B2 12/2012 Schaaf
8,333,764 B2 12/2012 Francischelli et al.
8,333,779 B2 12/2012 Smith et al.
8,334,468 B2 12/2012 Palmer et al.
8,336,753 B2 12/2012 Olson et al.
8,336,754 B2 12/2012 Cappola et al.
8,342,377 B2 1/2013 Milliman et al.
8,342,378 B2 1/2013 Marczyk et al.
8,342,379 B2 1/2013 Whitman et al.
8,343,150 B2 1/2013 Artale
8,347,978 B2 1/2013 Forster et al.
8,348,118 B2 1/2013 Segura
8,348,123 B2 1/2013 Scirica et al.
8,348,124 B2 1/2013 Scirica
8,348,125 B2 1/2013 Viola et al.
8,348,126 B2 1/2013 Olson et al.
8,348,127 B2 1/2013 Marczyk
8,348,129 B2 1/2013 Bedi et al.
8,348,130 B2 1/2013 Shah et al.
8,348,131 B2 1/2013 Omaits et al.
8,348,837 B2 1/2013 Wenchell
8,348,959 B2 1/2013 Wolford et al.
8,348,972 B2 1/2013 Soltz et al.
8,349,987 B2 1/2013 Kapiamba et al.
8,352,004 B2 1/2013 Mannheimer et al.
8,353,437 B2 1/2013 Boudreaux
8,353,438 B2 1/2013 Baxter, III et al.
8,353,439 B2 1/2013 Baxter, III et al.
8,356,740 B1 1/2013 Knodel
8,357,144 B2 1/2013 Whitman et al.
8,357,158 B2 1/2013 McKenna et al.
8,357,161 B2 1/2013 Mueller
8,359,174 B2 1/2013 Nakashima et al.
8,360,296 B2 1/2013 Zingman
8,360,297 B2 1/2013 Shelton, IV et al.
8,360,298 B2 1/2013 Farascioni et al.
8,360,299 B2 1/2013 Zemlok et al.
8,361,501 B2 1/2013 DiTizio et al.
D676,866 S 2/2013 Chaudhri
8,365,972 B2 2/2013 Aranyi et al.
8,365,973 B1 2/2013 White et al.
8,365,975 B1 2/2013 Manoux et al.
8,365,976 B2 2/2013 Hess et al.
8,366,559 B2 2/2013 Papenfuss et al.
8,366,719 B2 2/2013 Markey et al.
8,366,787 B2 2/2013 Brown et al.
8,369,056 B2 2/2013 Senriuchi et al.
8,371,393 B2 2/2013 Higuchi et al.
8,371,491 B2 2/2013 Huitema et al.
8,371,492 B2 2/2013 Aranyi et al.
8,371,493 B2 2/2013 Aranyi et al.
8,371,494 B2 2/2013 Racenet et al.
8,372,094 B2 2/2013 Bettuchi et al.
8,376,865 B2 2/2013 Forster et al.
8,377,029 B2 2/2013 Nagao et al.
8,377,044 B2 2/2013 Coe et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,382,773 B2 2/2013 Whitfield et al.
8,382,790 B2 2/2013 Uenohara et al.
D677,273 S 3/2013 Randall et al.
8,387,848 B2 3/2013 Johnson et al.
8,388,633 B2 3/2013 Rousseau et al.
8,389,588 B2 3/2013 Ringeisen et al.
8,393,513 B2 3/2013 Jankowski
8,393,514 B2 3/2013 Shelton, IV et al.
8,393,516 B2 3/2013 Kostrzewski
8,397,832 B2 3/2013 Blickle et al.
8,397,971 B2 3/2013 Yates et al.
8,397,973 B1 3/2013 Hausen
8,398,633 B2 3/2013 Mueller
8,398,669 B2 3/2013 Kim
8,398,673 B2 3/2013 Hinchliffe et al.
8,398,674 B2 3/2013 Prestel
8,400,851 B2 3/2013 Byun
8,403,138 B2 3/2013 Weisshaupt et al.
8,403,196 B2 3/2013 Beardsley et al.
8,403,198 B2 3/2013 Sorrentino et al.
8,403,832 B2 3/2013 Cunningham et al.
8,403,945 B2 3/2013 Whitfield et al.
8,403,946 B2 3/2013 Whitfield et al.
8,403,950 B2 3/2013 Palmer et al.
8,408,439 B2 4/2013 Huang et al.
8,408,442 B2 4/2013 Racenet et al.
8,409,079 B2 4/2013 Okamoto et al.
8,409,174 B2 4/2013 Omori
8,409,175 B2 4/2013 Lee et al.
8,409,222 B2 4/2013 Whitfield et al.
8,409,223 B2 4/2013 Sorrentino et al.
8,411,500 B2 4/2013 Gapihan et al.
8,413,661 B2 4/2013 Rousseau et al.
8,413,870 B2 4/2013 Pastorelli et al.
8,413,871 B2 4/2013 Racenet et al.
8,413,872 B2 4/2013 Patel
8,414,577 B2 4/2013 Boudreaux et al.
8,414,598 B2 4/2013 Brock et al.
8,418,073 B2 4/2013 Mohr et al.
8,418,906 B2 4/2013 Farascioni et al.
8,418,907 B2 4/2013 Johnson et al.
8,418,908 B1 4/2013 Beardsley
8,418,909 B2 4/2013 Kostrzewski
8,419,635 B2 4/2013 Shelton, IV et al.
8,419,717 B2 4/2013 Diolaiti et al.
8,419,747 B2 4/2013 Hinman et al.
8,419,754 B2 4/2013 Laby et al.
8,423,182 B2 4/2013 Robinson et al.
8,424,737 B2 4/2013 Scirica
8,424,739 B2 4/2013 Racenet et al.
8,424,740 B2 4/2013 Shelton, IV et al.
8,424,741 B2 4/2013 McGuckin, Jr. et al.
8,425,600 B2 4/2013 Maxwell
8,427,430 B2 4/2013 Lee et al.
8,430,292 B2 4/2013 Patel et al.
8,430,892 B2 4/2013 Bindra et al.
8,430,898 B2 4/2013 Wiener et al.
8,435,257 B2 5/2013 Smith et al.
8,439,246 B1 5/2013 Knodel
8,444,036 B2 5/2013 Shelton, IV
8,444,037 B2 5/2013 Nicholas et al.
8,444,549 B2 5/2013 Viola et al.
8,449,536 B2 5/2013 Selig
8,449,560 B2 5/2013 Roth et al.
8,453,904 B2 6/2013 Eskaros et al.
8,453,906 B2 6/2013 Huang et al.
8,453,907 B2 6/2013 Laurent et al.
8,453,908 B2 6/2013 Bedi et al.
8,453,912 B2 6/2013 Mastri et al.
8,453,914 B2 6/2013 Laurent et al.
8,454,495 B2 6/2013 Kawano et al.
8,454,551 B2 6/2013 Allen et al.
8,454,628 B2 6/2013 Smith et al.
8,454,640 B2 6/2013 Johnston et al.
8,457,757 B2 6/2013 Cauller et al.
8,459,520 B2 6/2013 Giordano et al.
8,459,521 B2 6/2013 Zemlok et al.
8,459,524 B2 6/2013 Pribanic et al.
8,459,525 B2 6/2013 Yates et al.
8,464,922 B2 6/2013 Marczyk
8,464,923 B2 6/2013 Shelton, IV
8,464,924 B2 6/2013 Gresham et al.
8,464,925 B2 6/2013 Hull et al.
8,465,475 B2 6/2013 Isbell, Jr.
8,465,502 B2 6/2013 Zergiebel
8,465,515 B2 6/2013 Drew et al.
8,469,254 B2 6/2013 Czernik et al.
8,469,946 B2 6/2013 Sugita
8,469,973 B2 6/2013 Meade et al.
8,470,355 B2 6/2013 Skalla et al.
D686,240 S 7/2013 Lin
8,474,677 B2 7/2013 Woodard, Jr. et al.
8,475,453 B2 7/2013 Marczyk et al.
8,475,454 B1 7/2013 Alshemari
8,475,474 B2 7/2013 Bombard et al.
8,479,968 B2 7/2013 Hodgkinson et al.
8,479,969 B2 7/2013 Shelton, IV
8,480,703 B2 7/2013 Nicholas et al.
8,483,509 B2 7/2013 Matsuzaka
8,485,412 B2 7/2013 Shelton, IV et al.
8,485,413 B2 7/2013 Scheib et al.
8,485,970 B2 7/2013 Widenhouse et al.
8,487,199 B2 7/2013 Palmer et al.
8,487,487 B2 7/2013 Dietz et al.
8,490,851 B2 7/2013 Blier et al.
8,490,853 B2 7/2013 Criscuolo et al.
8,491,581 B2 7/2013 Deville et al.
8,491,603 B2 7/2013 Yeung et al.
8,496,153 B2 7/2013 Demmy et al.
8,496,154 B2 7/2013 Marczyk et al.
8,496,156 B2 7/2013 Sniffin et al.
8,496,683 B2 7/2013 Prommersberger et al.
8,499,992 B2 8/2013 Whitman et al.
8,499,993 B2 8/2013 Shelton, IV et al.
8,500,721 B2 8/2013 Jinno
8,500,762 B2 8/2013 Sholev et al.
8,502,091 B2 8/2013 Palmer et al.
8,505,799 B2 8/2013 Viola et al.
8,505,801 B2 8/2013 Ehrenfels et al.
8,506,555 B2 8/2013 Ruiz Morales
8,506,557 B2 8/2013 Zemlok et al.
8,506,580 B2 8/2013 Zergiebel et al.
8,506,581 B2 8/2013 Wingardner, III et al.
8,511,308 B2 8/2013 Hecox et al.
8,512,359 B2 8/2013 Whitman et al.
8,512,402 B2 8/2013 Marczyk et al.
8,517,239 B2 8/2013 Scheib et al.
8,517,241 B2 8/2013 Nicholas et al.
8,517,243 B2 8/2013 Giordano et al.
8,517,244 B2 8/2013 Shelton, IV et al.
8,518,024 B2 8/2013 Williams et al.
8,521,273 B2 8/2013 Kliman
8,523,042 B2 9/2013 Masiakos et al.
8,523,043 B2 9/2013 Ullrich et al.
8,523,881 B2 9/2013 Cabiri et al.
8,523,900 B2 9/2013 Jinno et al.
8,529,588 B2 9/2013 Ahlberg et al.
8,529,600 B2 9/2013 Woodard, Jr. et al.
8,529,819 B2 9/2013 Ostapoff et al.
8,532,747 B2 9/2013 Nock et al.
8,534,527 B2 9/2013 Brendel et al.
8,534,528 B2 9/2013 Shelton, IV
8,535,304 B2 9/2013 Sklar et al.
8,535,340 B2 9/2013 Allen
8,539,866 B2 9/2013 Nayak et al.
8,540,128 B2 9/2013 Shelton, IV et al.
8,540,129 B2 9/2013 Baxter, III et al.
8,540,130 B2 9/2013 Moore et al.
8,540,131 B2 9/2013 Swayze
8,540,133 B2 9/2013 Bedi et al.
8,540,733 B2 9/2013 Whitman et al.
8,540,735 B2 9/2013 Mitelberg et al.
8,550,984 B2 10/2013 Takemoto
8,551,076 B2 10/2013 Duval et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,555,660 B2 10/2013 Takenaka et al.
8,556,151 B2 10/2013 Viola
8,556,918 B2 10/2013 Bauman et al.
8,556,935 B1 10/2013 Knodel et al.
8,560,147 B2 10/2013 Taylor et al.
8,561,617 B2 10/2013 Lindh et al.
8,561,870 B2 10/2013 Baxter, III et al.
8,561,871 B2 10/2013 Rajappa et al.
8,561,873 B2 10/2013 Ingmanson et al.
8,562,598 B2 10/2013 Falkenstein et al.
8,567,656 B2 10/2013 Shelton, IV et al.
8,568,416 B2 10/2013 Schmitz et al.
8,568,425 B2 10/2013 Ross et al.
D692,916 S 11/2013 Granchi et al.
8,573,459 B2 11/2013 Smith et al.
8,573,461 B2 11/2013 Shelton, IV et al.
8,573,462 B2 11/2013 Smith et al.
8,573,465 B2 11/2013 Shelton, IV
8,574,199 B2 11/2013 von Bulow et al.
8,574,263 B2 11/2013 Mueller
8,575,880 B2 11/2013 Grantz
8,575,895 B2 11/2013 Garrastacho et al.
8,579,176 B2 11/2013 Smith et al.
8,579,178 B2 11/2013 Holsten et al.
8,579,897 B2 11/2013 Vakharia et al.
8,579,937 B2 11/2013 Gresham
8,584,919 B2 11/2013 Hueil et al.
8,584,920 B2 11/2013 Hodgkinson
8,584,921 B2 11/2013 Scirica
8,585,583 B2 11/2013 Sakaguchi et al.
8,585,721 B2 11/2013 Kirsch
8,590,760 B2 11/2013 Cummins et al.
8,590,762 B2 11/2013 Hess et al.
8,590,764 B2 11/2013 Hartwick et al.
8,596,515 B2 12/2013 Okoniewski
8,597,745 B2 12/2013 Farnsworth et al.
8,599,450 B2 12/2013 Kubo et al.
8,602,287 B2 12/2013 Yates et al.
8,602,288 B2 12/2013 Shelton, IV et al.
8,603,077 B2 12/2013 Cooper et al.
8,603,089 B2 12/2013 Viola
8,603,110 B2 12/2013 Maruyama et al.
8,603,135 B2 12/2013 Mueller
8,608,043 B2 12/2013 Scirica
8,608,044 B2 12/2013 Hueil et al.
8,608,045 B2 12/2013 Smith et al.
8,608,046 B2 12/2013 Laurent et al.
8,608,745 B2 12/2013 Guzman et al.
8,613,383 B2 12/2013 Beckman et al.
8,616,427 B2 12/2013 Viola
8,616,431 B2 12/2013 Timm et al.
8,622,274 B2 1/2014 Yates et al.
8,622,275 B2 1/2014 Baxter, III et al.
8,627,993 B2 1/2014 Smith et al.
8,627,994 B2 1/2014 Zemlok et al.
8,627,995 B2 1/2014 Smith et al.
8,628,518 B2 1/2014 Blumenkranz et al.
8,628,544 B2 1/2014 Farascioni
8,628,545 B2 1/2014 Cabrera et al.
8,631,987 B2 1/2014 Shelton, IV et al.
8,631,992 B1 1/2014 Hausen et al.
8,631,993 B2 1/2014 Kostrzewski
8,632,462 B2 1/2014 Yoo et al.
8,632,525 B2 1/2014 Kerr et al.
8,632,535 B2 1/2014 Shelton, IV et al.
8,632,539 B2 1/2014 Twomey et al.
8,632,563 B2 1/2014 Nagase et al.
8,636,187 B2 1/2014 Hueil et al.
8,636,190 B2 1/2014 Zemlok et al.
8,636,191 B2 1/2014 Meagher
8,636,193 B2 1/2014 Whitman et al.
8,636,736 B2 1/2014 Yates et al.
8,636,766 B2 1/2014 Milliman et al.
8,639,936 B2 1/2014 Hu et al.
8,640,788 B2 2/2014 Dachs, II et al.
8,646,674 B2 2/2014 Schulte et al.
8,647,258 B2 2/2014 Aranyi et al.
8,652,120 B2 2/2014 Giordano et al.
8,652,151 B2 2/2014 Lehman et al.
8,657,174 B2 2/2014 Yates et al.
8,657,175 B2 2/2014 Sonnenschein et al.
8,657,176 B2 2/2014 Shelton, IV et al.
8,657,177 B2 2/2014 Scirica et al.
8,657,178 B2 2/2014 Hueil et al.
8,657,482 B2 2/2014 Malackowski et al.
8,657,808 B2 2/2014 McPherson et al.
8,657,814 B2 2/2014 Werneth et al.
8,657,821 B2 2/2014 Palermo
D701,238 S 3/2014 Lai et al.
8,662,370 B2 3/2014 Takei
8,663,106 B2 3/2014 Stivoric et al.
8,663,192 B2 3/2014 Hester et al.
8,663,245 B2 3/2014 Francischelli et al.
8,663,262 B2 3/2014 Smith et al.
8,663,270 B2 3/2014 Donnigan et al.
8,664,792 B2 3/2014 Rebsdorf
8,668,129 B2 3/2014 Olson
8,668,130 B2 3/2014 Hess et al.
8,672,206 B2 3/2014 Aranyi et al.
8,672,207 B2 3/2014 Shelton, IV et al.
8,672,208 B2 3/2014 Hess et al.
8,672,922 B2 3/2014 Loh et al.
8,672,935 B2 3/2014 Okada et al.
8,672,951 B2 3/2014 Smith et al.
8,673,210 B2 3/2014 Deshays
8,675,820 B2 3/2014 Baic et al.
8,678,263 B2 3/2014 Viola
8,678,994 B2 3/2014 Sonnenschein et al.
8,679,093 B2 3/2014 Farra
8,679,098 B2 3/2014 Hart
8,679,137 B2 3/2014 Bauman et al.
8,679,154 B2 3/2014 Smith et al.
8,679,156 B2 3/2014 Smith et al.
8,679,454 B2 3/2014 Guire et al.
8,684,248 B2 4/2014 Milliman
8,684,249 B2 4/2014 Racenet et al.
8,684,250 B2 4/2014 Bettuchi et al.
8,684,253 B2 4/2014 Giordano et al.
8,684,962 B2 4/2014 Kirschenman et al.
8,685,004 B2 4/2014 Zemlock et al.
8,685,020 B2 4/2014 Weizman et al.
8,690,893 B2 4/2014 Deitch et al.
8,695,866 B2 4/2014 Leimbach et al.
8,696,665 B2 4/2014 Hunt et al.
8,701,958 B2 4/2014 Shelton, IV et al.
8,701,959 B2 4/2014 Shah
8,708,210 B2 4/2014 Zemlok et al.
8,708,211 B2 4/2014 Zemlok et al.
8,708,213 B2 4/2014 Shelton, IV et al.
8,714,352 B2 5/2014 Farascioni et al.
8,714,429 B2 5/2014 Demmy
8,714,430 B2 5/2014 Natarajan et al.
8,715,256 B2 5/2014 Greener
8,715,302 B2 5/2014 Ibrahim et al.
8,720,766 B2 5/2014 Hess et al.
8,721,630 B2 5/2014 Ortiz et al.
8,721,666 B2 5/2014 Schroeder et al.
8,727,197 B2 5/2014 Hess et al.
8,727,199 B2 5/2014 Wenchell
8,727,200 B2 5/2014 Roy
8,727,961 B2 5/2014 Ziv
8,728,099 B2 5/2014 Cohn et al.
8,728,119 B2 5/2014 Cummins
8,733,470 B2 5/2014 Matthias et al.
8,733,612 B2 5/2014 Ma
8,733,613 B2 5/2014 Huitema et al.
8,733,614 B2 5/2014 Ross et al.
8,734,336 B2 5/2014 Bonadio et al.
8,734,359 B2 5/2014 Ibanez et al.
8,734,478 B2 5/2014 Widenhouse et al.
8,734,831 B2 5/2014 Kim et al.
8,739,033 B2 5/2014 Rosenberg
8,739,417 B2 6/2014 Tokunaga et al.
8,740,034 B2 6/2014 Morgan et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,740,037 B2 6/2014 Shelton, IV et al.
8,740,038 B2 6/2014 Shelton, IV et al.
8,740,987 B2 6/2014 Geremakis et al.
8,746,529 B2 6/2014 Shelton, IV et al.
8,746,530 B2 6/2014 Giordano et al.
8,746,533 B2 6/2014 Whitman et al.
8,746,535 B2 6/2014 Shelton, IV et al.
8,747,238 B2 6/2014 Shelton, IV et al.
8,747,441 B2 6/2014 Konieczynski et al.
8,752,264 B2 6/2014 Ackley et al.
8,752,699 B2 6/2014 Morgan et al.
8,752,747 B2 6/2014 Shelton, IV et al.
8,752,748 B2 6/2014 Whitman et al.
8,752,749 B2 6/2014 Moore et al.
8,753,664 B2 6/2014 Dao et al.
8,757,287 B2 6/2014 Mak et al.
8,757,465 B2 6/2014 Woodard, Jr. et al.
8,758,235 B2 6/2014 Jaworek
8,758,366 B2 6/2014 McLean et al.
8,758,391 B2 6/2014 Swayze et al.
8,758,438 B2 6/2014 Boyce et al.
8,763,875 B2 7/2014 Morgan et al.
8,763,877 B2 7/2014 Schall et al.
8,763,879 B2 7/2014 Shelton, IV et al.
8,764,732 B2 7/2014 Hartwell
8,770,458 B2 7/2014 Scirica
8,770,459 B2 7/2014 Racenet et al.
8,770,460 B2 7/2014 Belzer
8,771,169 B2 7/2014 Whitman et al.
8,771,260 B2 7/2014 Conlon et al.
8,777,004 B2 7/2014 Shelton, IV et al.
8,777,082 B2 7/2014 Scirica
8,777,083 B2 7/2014 Racenet et al.
8,777,898 B2 7/2014 Suon et al.
8,783,541 B2 7/2014 Shelton, IV et al.
8,783,542 B2 7/2014 Riestenberg et al.
8,783,543 B2 7/2014 Shelton, IV et al.
8,784,304 B2 7/2014 Mikkaichi et al.
8,784,404 B2 7/2014 Doyle et al.
8,784,415 B2 7/2014 Malackowski et al.
8,789,737 B2 7/2014 Hodgkinson et al.
8,789,739 B2 7/2014 Swensgard
8,789,740 B2 7/2014 Baxter, III et al.
8,789,741 B2 7/2014 Baxter, III et al.
8,790,658 B2 7/2014 Cigarini et al.
8,790,684 B2 7/2014 Dave et al.
D711,905 S 8/2014 Morrison et al.
8,794,496 B2 8/2014 Scirica
8,794,497 B2 8/2014 Zingman
8,795,276 B2 8/2014 Dietz et al.
8,795,308 B2 8/2014 Valin
8,795,324 B2 8/2014 Kawai et al.
8,796,995 B2 8/2014 Cunanan et al.
8,800,681 B2 8/2014 Rousson et al.
8,800,837 B2 8/2014 Zemlok
8,800,838 B2 8/2014 Shelton, IV
8,800,839 B2 8/2014 Beetel
8,800,840 B2 8/2014 Jankowski
8,800,841 B2 8/2014 Ellerhorst et al.
8,801,710 B2 8/2014 Ullrich et al.
8,801,734 B2 8/2014 Shelton, IV et al.
8,801,735 B2 8/2014 Shelton, IV et al.
8,801,752 B2 8/2014 Fortier et al.
8,801,801 B2 8/2014 Datta et al.
8,806,973 B2 8/2014 Ross et al.
8,807,414 B2 8/2014 Ross et al.
8,808,161 B2 8/2014 Gregg et al.
8,808,164 B2 8/2014 Hoffman et al.
8,808,274 B2 8/2014 Hartwell
8,808,294 B2 8/2014 Fox et al.
8,808,308 B2 8/2014 Boukhny et al.
8,808,311 B2 8/2014 Heinrich et al.
8,808,325 B2 8/2014 Hess et al.
8,810,197 B2 8/2014 Juergens
8,811,017 B2 8/2014 Fujii et al.
8,813,866 B2 8/2014 Suzuki
8,814,024 B2 8/2014 Woodard, Jr. et al.
8,814,025 B2 8/2014 Miller et al.
8,814,836 B2 8/2014 Ignon et al.
8,815,594 B2 8/2014 Harris et al.
8,818,523 B2 8/2014 Olson et al.
8,820,603 B2 9/2014 Shelton, IV et al.
8,820,605 B2 9/2014 Shelton, IV
8,820,606 B2 9/2014 Hodgkinson
8,820,607 B2 9/2014 Marczyk
8,820,608 B2 9/2014 Miyamoto
8,821,514 B2 9/2014 Aranyi
8,822,934 B2 9/2014 Sayeh et al.
8,825,164 B2 9/2014 Tweden et al.
8,827,133 B2 9/2014 Shelton, IV et al.
8,827,134 B2 9/2014 Viola et al.
8,827,903 B2 9/2014 Shelton, IV et al.
8,833,219 B2 9/2014 Pierce
8,833,630 B2 9/2014 Milliman
8,833,632 B2 9/2014 Swensgard
8,834,353 B2 9/2014 Dejima et al.
8,834,498 B2 9/2014 Byrum et al.
8,834,518 B2 9/2014 Faller et al.
8,840,003 B2 9/2014 Morgan et al.
8,840,603 B2 9/2014 Shelton, IV et al.
8,840,609 B2 9/2014 Stuebe
8,840,876 B2 9/2014 Eemeta et al.
8,844,789 B2 9/2014 Shelton, IV et al.
8,844,790 B2 9/2014 Demmy et al.
8,851,215 B2 10/2014 Goto
8,851,354 B2 10/2014 Swensgard et al.
8,852,174 B2 10/2014 Burbank
8,852,185 B2 10/2014 Twomey
8,852,199 B2 10/2014 Deslauriers et al.
8,852,218 B2 10/2014 Hughett, Sr. et al.
8,857,693 B2 10/2014 Schuckmann et al.
8,857,694 B2 10/2014 Shelton, IV et al.
8,858,538 B2 10/2014 Belson et al.
8,858,571 B2 10/2014 Shelton, IV et al.
8,858,590 B2 10/2014 Shelton, IV et al.
8,864,007 B2 10/2014 Widenhouse et al.
8,864,009 B2 10/2014 Shelton, IV et al.
8,864,010 B2 10/2014 Williams
8,870,050 B2 10/2014 Hodgkinson
8,870,867 B2 10/2014 Walberg et al.
8,870,912 B2 10/2014 Brisson et al.
8,875,971 B2 11/2014 Hall et al.
8,875,972 B2 11/2014 Weisenburgh, II et al.
8,876,857 B2 11/2014 Burbank
8,876,858 B2 11/2014 Braun
8,887,979 B2 11/2014 Mastri et al.
8,888,688 B2 11/2014 Julian et al.
8,888,695 B2 11/2014 Piskun et al.
8,888,792 B2 11/2014 Harris et al.
8,888,809 B2 11/2014 Davison et al.
8,893,946 B2 11/2014 Boudreaux et al.
8,893,949 B2 11/2014 Shelton, IV et al.
8,894,647 B2 11/2014 Beardsley et al.
8,894,654 B2 11/2014 Anderson
8,899,460 B2 12/2014 Wojcicki
8,899,461 B2 12/2014 Farascioni
8,899,462 B2 12/2014 Kostrzewski et al.
8,899,463 B2 12/2014 Schall et al.
8,899,464 B2 12/2014 Hueil et al.
8,899,465 B2 12/2014 Shelton, IV et al.
8,899,466 B2 12/2014 Baxter, III et al.
8,900,267 B2 12/2014 Woolfson et al.
8,905,287 B2 12/2014 Racenet et al.
8,905,977 B2 12/2014 Shelton et al.
8,910,846 B2 12/2014 Viola
8,911,426 B2 12/2014 Coppeta et al.
8,911,448 B2 12/2014 Stein
8,911,460 B2 12/2014 Neurohr et al.
8,911,471 B2 12/2014 Spivey et al.
8,920,433 B2 12/2014 Barrier et al.
8,920,435 B2 12/2014 Smith et al.
8,920,438 B2 12/2014 Aranyi et al.
8,920,443 B2 12/2014 Hiles et al.
8,920,444 B2 12/2014 Hiles et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,922,163 B2 12/2014 Macdonald
8,925,782 B2 1/2015 Shelton, IV
8,925,783 B2 1/2015 Zemlok et al.
8,925,788 B2 1/2015 Hess et al.
8,926,506 B2 1/2015 Widenhouse et al.
8,926,598 B2 1/2015 Mollere et al.
8,931,576 B2 1/2015 Iwata
8,931,679 B2 1/2015 Kostrzewski
8,931,680 B2 1/2015 Milliman
8,931,682 B2 1/2015 Timm et al.
8,936,614 B2 1/2015 Allen, IV
8,939,343 B2 1/2015 Milliman et al.
8,939,344 B2 1/2015 Olson et al.
8,945,163 B2 2/2015 Voegele et al.
8,955,732 B2 2/2015 Zemlok et al.
8,956,342 B1 2/2015 Russo et al.
8,956,390 B2 2/2015 Shah et al.
8,958,860 B2 2/2015 Banerjee et al.
8,960,519 B2 2/2015 Whitman et al.
8,960,520 B2 2/2015 McCuen
8,960,521 B2 2/2015 Kostrzewski
8,961,191 B2 2/2015 Hanshew
8,961,504 B2 2/2015 Hoarau et al.
8,963,714 B2 2/2015 Medhal et al.
D725,674 S 3/2015 Jung et al.
8,967,443 B2 3/2015 McCuen
8,967,444 B2 3/2015 Beetel
8,967,446 B2 3/2015 Beardsley et al.
8,967,448 B2 3/2015 Carter et al.
8,968,276 B2 3/2015 Zemlok et al.
8,968,308 B2 3/2015 Horner et al.
8,968,312 B2 3/2015 Marczyk et al.
8,968,337 B2 3/2015 Whitfield et al.
8,968,340 B2 3/2015 Chowaniec et al.
8,968,355 B2 3/2015 Malkowski et al.
8,968,358 B2 3/2015 Reschke
8,970,507 B2 3/2015 Holbein et al.
8,973,803 B2 3/2015 Hall et al.
8,973,804 B2 3/2015 Hess et al.
8,973,805 B2 3/2015 Scirica et al.
8,974,440 B2 3/2015 Farritor et al.
8,974,542 B2 3/2015 Fujimoto et al.
8,974,932 B2 3/2015 McGahan et al.
8,978,954 B2 3/2015 Shelton, IV et al.
8,978,955 B2 3/2015 Aronhalt et al.
8,978,956 B2 3/2015 Schall et al.
8,979,843 B2 3/2015 Timm et al.
8,979,890 B2 3/2015 Boudreaux
8,982,195 B2 3/2015 Claus et al.
8,985,429 B2 3/2015 Balek et al.
8,986,302 B2 3/2015 Aldridge et al.
8,991,676 B2 3/2015 Hess et al.
8,991,677 B2 3/2015 Moore et al.
8,991,678 B2 3/2015 Wellman et al.
8,992,042 B2 3/2015 Eichenholz
8,992,422 B2 3/2015 Spivey et al.
8,992,565 B2 3/2015 Brisson et al.
8,996,165 B2 3/2015 Wang et al.
8,998,058 B2 4/2015 Moore et al.
8,998,059 B2 4/2015 Smith et al.
8,998,060 B2 4/2015 Bruewer et al.
8,998,061 B2 4/2015 Williams et al.
8,998,939 B2 4/2015 Price et al.
9,000,720 B2 4/2015 Stulen et al.
9,002,518 B2 4/2015 Manzo et al.
9,004,339 B1 4/2015 Park
9,005,230 B2 4/2015 Yates et al.
9,005,238 B2 4/2015 DeSantis et al.
9,005,243 B2 4/2015 Stopek et al.
9,010,606 B2 4/2015 Aranyi et al.
9,010,608 B2 4/2015 Casasanta, Jr. et al.
9,010,611 B2 4/2015 Ross et al.
9,011,439 B2 4/2015 Shalaby et al.
9,011,471 B2 4/2015 Timm et al.
9,016,539 B2 4/2015 Kostrzewski et al.
9,016,540 B2 4/2015 Whitman et al.
9,016,541 B2 4/2015 Viola et al.
9,016,542 B2 4/2015 Shelton, IV et al.
9,016,545 B2 4/2015 Aranyi et al.
9,017,331 B2 4/2015 Fox
9,017,355 B2 4/2015 Smith et al.
9,017,369 B2 4/2015 Renger et al.
9,017,371 B2 4/2015 Whitman et al.
9,021,684 B2 5/2015 Lenker et al.
9,023,014 B2 5/2015 Chowaniec et al.
9,023,069 B2 5/2015 Kasvikis et al.
9,023,071 B2 5/2015 Miller et al.
9,026,347 B2 5/2015 Gadh et al.
9,027,817 B2 5/2015 Milliman et al.
9,028,494 B2 5/2015 Shelton, IV et al.
9,028,495 B2 5/2015 Mueller et al.
9,028,519 B2 5/2015 Yates et al.
9,030,169 B2 5/2015 Christensen et al.
9,033,203 B2 5/2015 Woodard, Jr. et al.
9,033,204 B2 5/2015 Shelton, IV et al.
9,034,505 B2 5/2015 Detry et al.
9,038,881 B1 5/2015 Schaller et al.
9,039,690 B2 5/2015 Kersten et al.
9,039,694 B2 5/2015 Ross et al.
9,039,720 B2 5/2015 Madan
9,043,027 B2 5/2015 Durant et al.
9,044,227 B2 6/2015 Shelton, IV et al.
9,044,228 B2 6/2015 Woodard, Jr. et al.
9,044,229 B2 6/2015 Scheib et al.
9,044,230 B2 6/2015 Morgan et al.
9,044,241 B2 6/2015 Barner et al.
9,044,261 B2 6/2015 Houser
9,044,281 B2 6/2015 Pool et al.
9,050,083 B2 6/2015 Yates et al.
9,050,084 B2 6/2015 Schmid et al.
9,050,100 B2 6/2015 Yates et al.
9,050,120 B2 6/2015 Swarup et al.
9,050,123 B2 6/2015 Krause et al.
9,050,176 B2 6/2015 Datta et al.
9,050,192 B2 6/2015 Mansmann
9,055,941 B2 6/2015 Schmid et al.
9,055,942 B2 6/2015 Balbierz et al.
9,055,943 B2 6/2015 Zemlok et al.
9,055,944 B2 6/2015 Hodgkinson et al.
9,055,961 B2 6/2015 Manzo et al.
9,060,770 B2 6/2015 Shelton, IV et al.
9,060,776 B2 6/2015 Yates et al.
9,060,794 B2 6/2015 Kang et al.
9,060,894 B2 6/2015 Wubbeling
9,061,392 B2 6/2015 Forgues et al.
9,072,515 B2 7/2015 Hall et al.
9,072,523 B2 7/2015 Houser et al.
9,072,535 B2 7/2015 Shelton, IV et al.
9,072,536 B2 7/2015 Shelton, IV et al.
9,078,653 B2 7/2015 Leimbach et al.
9,084,601 B2 7/2015 Moore et al.
9,084,602 B2 7/2015 Gleiman
9,086,875 B2 7/2015 Harrat et al.
9,089,326 B2 7/2015 Krumanaker et al.
9,089,330 B2 7/2015 Widenhouse et al.
9,089,352 B2 7/2015 Jeong
9,089,360 B2 7/2015 Messerly et al.
9,091,588 B2 7/2015 Lefler
D736,792 S 8/2015 Brinda et al.
9,095,339 B2 8/2015 Moore et al.
9,095,346 B2 8/2015 Houser et al.
9,095,362 B2 8/2015 Dachs, II et al.
9,095,367 B2 8/2015 Olson et al.
9,096,033 B2 8/2015 Holop et al.
9,099,863 B2 8/2015 Smith et al.
9,099,877 B2 8/2015 Banos et al.
9,101,358 B2 8/2015 Kerr et al.
9,101,385 B2 8/2015 Shelton, IV et al.
9,101,475 B2 8/2015 Wei et al.
9,107,663 B2 8/2015 Swensgard
9,107,690 B2 8/2015 Bales, Jr. et al.
9,110,587 B2 8/2015 Kim et al.
9,113,862 B2 8/2015 Morgan et al.
9,113,864 B2 8/2015 Morgan et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,113,865 B2 8/2015 Shelton, IV et al.
9,113,868 B2 8/2015 Felder et al.
9,113,873 B2 8/2015 Marczyk et al.
9,113,874 B2 8/2015 Shelton, IV et al.
9,113,876 B2 8/2015 Zemlok et al.
9,113,879 B2 8/2015 Felder et al.
9,113,880 B2 8/2015 Zemlok et al.
9,113,881 B2 8/2015 Scirica
9,113,883 B2 8/2015 Aronhalt et al.
9,113,884 B2 8/2015 Shelton, IV et al.
9,113,887 B2 8/2015 Behnke, II et al.
9,119,615 B2 9/2015 Felder et al.
9,119,657 B2 9/2015 Shelton, IV et al.
9,119,898 B2 9/2015 Bayon et al.
9,119,957 B2 9/2015 Gantz et al.
9,123,286 B2 9/2015 Park
9,124,097 B2 9/2015 Cruz
9,125,654 B2 9/2015 Aronhalt et al.
9,125,662 B2 9/2015 Shelton, IV
9,126,317 B2 9/2015 Lawton et al.
9,131,835 B2 9/2015 Widenhouse et al.
9,131,940 B2 9/2015 Huitema et al.
9,131,950 B2 9/2015 Matthew
9,131,957 B2 9/2015 Skarbnik et al.
9,138,225 B2 9/2015 Huang et al.
9,138,226 B2 9/2015 Racenet et al.
9,144,455 B2 9/2015 Kennedy et al.
D741,882 S 10/2015 Shmilov et al.
9,149,274 B2 10/2015 Spivey et al.
9,149,324 B2 10/2015 Huang et al.
9,149,325 B2 10/2015 Worrell et al.
9,153,994 B2 10/2015 Wood et al.
9,161,753 B2 10/2015 Prior
9,161,769 B2 10/2015 Stoddard et al.
9,161,803 B2 10/2015 Yates et al.
9,161,807 B2 10/2015 Garrison
9,168,038 B2 10/2015 Shelton, IV et al.
9,168,039 B1 10/2015 Knodel
9,168,042 B2 10/2015 Milliman
9,168,054 B2 10/2015 Turner et al.
9,168,144 B2 10/2015 Rivin et al.
9,179,911 B2 11/2015 Morgan et al.
9,179,912 B2 11/2015 Yates et al.
9,180,223 B2 11/2015 Yu et al.
9,182,244 B2 11/2015 Luke et al.
9,186,046 B2 11/2015 Ramamurthy et al.
9,186,137 B2 11/2015 Farascioni et al.
9,186,140 B2 11/2015 Hiles et al.
9,186,142 B2 11/2015 Fanelli et al.
9,186,143 B2 11/2015 Timm et al.
9,186,148 B2 11/2015 Felder et al.
9,186,221 B2 11/2015 Burbank
9,192,380 B2 11/2015 (Tarinelli) Racenet et al.
9,192,384 B2 11/2015 Bettuchi
9,192,430 B2 11/2015 Rachlin et al.
9,192,434 B2 11/2015 Twomey et al.
9,193,045 B2 11/2015 Saur et al.
9,197,079 B2 11/2015 Yip et al.
D744,528 S 12/2015 Agrawal
9,198,642 B2 12/2015 Storz
9,198,644 B2 12/2015 Balek et al.
9,198,661 B2 12/2015 Swensgard
9,198,662 B2 12/2015 Barton et al.
9,198,683 B2 12/2015 Friedman et al.
9,204,830 B2 12/2015 Zand et al.
9,204,877 B2 12/2015 Whitman et al.
9,204,878 B2 12/2015 Hall et al.
9,204,879 B2 12/2015 Shelton, IV
9,204,880 B2 12/2015 Baxter, III et al.
9,204,923 B2 12/2015 Manzo et al.
9,204,924 B2 12/2015 Marczyk et al.
9,211,120 B2 12/2015 Scheib et al.
9,211,121 B2 12/2015 Hall et al.
9,211,122 B2 12/2015 Hagerty et al.
9,216,013 B2 12/2015 Scirica et al.
9,216,019 B2 12/2015 Schmid et al.
9,216,020 B2 12/2015 Zhang et al.
9,216,030 B2 12/2015 Fan et al.
9,216,062 B2 12/2015 Duque et al.
9,220,500 B2 12/2015 Swayze et al.
9,220,501 B2 12/2015 Baxter, III et al.
9,220,502 B2 12/2015 Zemlok et al.
9,220,508 B2 12/2015 Dannaher
9,220,559 B2 12/2015 Worrell et al.
9,220,570 B2 12/2015 Kim et al.
D746,854 S 1/2016 Shardlow et al.
9,226,750 B2 1/2016 Weir et al.
9,226,751 B2 1/2016 Shelton, IV et al.
9,226,754 B2 1/2016 D'Agostino et al.
9,226,761 B2 1/2016 Burbank
9,226,767 B2 1/2016 Stulen et al.
9,232,941 B2 1/2016 Mandakolathur Vasudevan et al.
9,232,945 B2 1/2016 Zingman
9,232,979 B2 1/2016 Parihar et al.
9,233,610 B2 1/2016 Kim et al.
9,237,891 B2 1/2016 Shelton, IV
9,237,892 B2 1/2016 Hodgkinson
9,237,895 B2 1/2016 McCarthy et al.
9,237,900 B2 1/2016 Boudreaux et al.
9,237,921 B2 1/2016 Messerly et al.
9,239,064 B2 1/2016 Helbig et al.
9,240,740 B2 1/2016 Zeng et al.
9,241,711 B2 1/2016 Ivanko
9,241,712 B2 1/2016 Zemlok et al.
9,241,714 B2 1/2016 Timm et al.
9,241,716 B2 1/2016 Whitman
9,241,731 B2 1/2016 Boudreaux et al.
9,244,524 B2 1/2016 Inoue et al.
D748,668 S 2/2016 Kim et al.
D749,623 S 2/2016 Gray et al.
D750,122 S 2/2016 Shardlow et al.
D750,129 S 2/2016 Kwon
9,254,131 B2 2/2016 Soltz et al.
9,259,274 B2 2/2016 Prisco
9,259,275 B2 2/2016 Burbank
9,261,172 B2 2/2016 Solomon et al.
9,265,500 B2 2/2016 Sorrentino et al.
9,265,516 B2 2/2016 Casey et al.
9,265,585 B2 2/2016 Wingardner et al.
9,271,718 B2 3/2016 Milad et al.
9,271,727 B2 3/2016 McGuckin, Jr. et al.
9,271,753 B2 3/2016 Butler et al.
9,271,799 B2 3/2016 Shelton, IV et al.
9,272,406 B2 3/2016 Aronhalt et al.
9,274,095 B2 3/2016 Humayun et al.
9,277,919 B2 3/2016 Timmer et al.
9,277,922 B2 3/2016 Carter et al.
9,282,962 B2 3/2016 Schmid et al.
9,282,963 B2 3/2016 Bryant
9,282,966 B2 3/2016 Shelton, IV et al.
9,282,974 B2 3/2016 Shelton, IV
9,283,028 B2 3/2016 Johnson
9,283,045 B2 3/2016 Rhee et al.
9,283,054 B2 3/2016 Morgan et al.
9,289,206 B2 3/2016 Hess et al.
9,289,207 B2 3/2016 Shelton, IV
9,289,210 B2 3/2016 Baxter, III et al.
9,289,211 B2 3/2016 Williams et al.
9,289,212 B2 3/2016 Shelton, IV et al.
9,289,225 B2 3/2016 Shelton, IV et al.
9,289,256 B2 3/2016 Shelton, IV et al.
9,293,757 B2 3/2016 Toussaint et al.
9,295,464 B2 3/2016 Shelton, IV et al.
9,295,465 B2 3/2016 Farascioni
9,295,466 B2 3/2016 Hodgkinson et al.
9,295,467 B2 3/2016 Scirica
9,295,468 B2 3/2016 Heinrich et al.
9,295,514 B2 3/2016 Shelton, IV et al.
9,295,522 B2 3/2016 Kostrzewski
9,295,565 B2 3/2016 McLean
9,295,784 B2 3/2016 Eggert et al.
9,301,691 B2 4/2016 Hufnagel et al.
9,301,752 B2 4/2016 Mandakolathur Vasudevan et al.
9,301,753 B2 4/2016 Aldridge et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,301,755 B2 4/2016 Shelton, IV et al.
9,301,759 B2 4/2016 Spivey et al.
9,307,965 B2 4/2016 Ming et al.
9,307,986 B2 4/2016 Hall et al.
9,307,987 B2 4/2016 Swensgard et al.
9,307,988 B2 4/2016 Shelton, IV
9,307,989 B2 4/2016 Shelton, IV et al.
9,307,994 B2 4/2016 Gresham et al.
9,308,009 B2 4/2016 Madan et al.
9,308,011 B2 4/2016 Chao et al.
9,308,646 B2 4/2016 Lim et al.
9,313,915 B2 4/2016 Niu et al.
9,314,246 B2 4/2016 Shelton, IV et al.
9,314,247 B2 4/2016 Shelton, IV et al.
9,314,261 B2 4/2016 Bales, Jr. et al.
9,314,339 B2 4/2016 Mansmann
9,314,908 B2 4/2016 Tanimoto et al.
9,320,518 B2 4/2016 Henderson et al.
9,320,520 B2 4/2016 Shelton, IV et al.
9,320,521 B2 4/2016 Shelton, IV et al.
9,320,523 B2 4/2016 Shelton, IV et al.
9,325,516 B2 4/2016 Pera et al.
D755,196 S 5/2016 Meyers et al.
D756,373 S 5/2016 Raskin et al.
D756,377 S 5/2016 Connolly et al.
D757,028 S 5/2016 Goldenberg et al.
9,326,767 B2 5/2016 Koch, Jr. et al.
9,326,768 B2 5/2016 Shelton, IV
9,326,769 B2 5/2016 Shelton, IV et al.
9,326,770 B2 5/2016 Shelton, IV et al.
9,326,771 B2 5/2016 Baxter, III et al.
9,326,788 B2 5/2016 Batross et al.
9,326,812 B2 5/2016 Waaler et al.
9,327,061 B2 5/2016 Govil et al.
9,331,721 B2 5/2016 Martinez Nuevo et al.
9,332,890 B2 5/2016 Ozawa
9,332,974 B2 5/2016 Henderson et al.
9,332,984 B2 5/2016 Weaner et al.
9,332,987 B2 5/2016 Leimbach et al.
9,333,040 B2 5/2016 Shellenberger et al.
9,333,082 B2 5/2016 Wei et al.
9,337,668 B2 5/2016 Yip
9,339,226 B2 5/2016 van der Walt et al.
9,345,477 B2 5/2016 Anim et al.
9,345,479 B2 5/2016 (Tarinelli) Racenet et al.
9,345,480 B2 5/2016 Hessler et al.
9,345,481 B2 5/2016 Hall et al.
9,351,726 B2 5/2016 Leimbach et al.
9,351,727 B2 5/2016 Leimbach et al.
9,351,728 B2 5/2016 Sniffin et al.
9,351,730 B2 5/2016 Schmid et al.
9,351,731 B2 5/2016 Carter et al.
9,351,732 B2 5/2016 Hodgkinson
D758,433 S 6/2016 Lee et al.
D759,063 S 6/2016 Chen
9,358,003 B2 6/2016 Hall et al.
9,358,005 B2 6/2016 Shelton, IV et al.
9,358,015 B2 6/2016 Sorrentino et al.
9,358,031 B2 6/2016 Manzo
9,364,217 B2 6/2016 Kostrzewski et al.
9,364,219 B2 6/2016 Olson et al.
9,364,220 B2 6/2016 Williams
9,364,226 B2 6/2016 Zemlok et al.
9,364,229 B2 6/2016 D'Agostino et al.
9,364,230 B2 6/2016 Shelton, IV et al.
9,364,231 B2 6/2016 Wenchell
9,364,233 B2 6/2016 Alexander, III et al.
9,364,279 B2 6/2016 Houser et al.
9,368,991 B2 6/2016 Qahouq
9,370,341 B2 6/2016 Ceniccola et al.
9,370,358 B2 6/2016 Shelton, IV et al.
9,370,364 B2 6/2016 Smith et al.
9,375,206 B2 6/2016 Vidal et al.
9,375,218 B2 6/2016 Wheeler et al.
9,375,230 B2 6/2016 Ross et al.
9,375,232 B2 6/2016 Hunt et al.
9,375,255 B2 6/2016 Houser et al.
D761,309 S 7/2016 Lee et al.
9,381,058 B2 7/2016 Houser et al.
9,383,881 B2 7/2016 Day et al.
9,386,983 B2 7/2016 Swensgard et al.
9,386,984 B2 7/2016 Aronhalt et al.
9,386,985 B2 7/2016 Koch, Jr. et al.
9,386,988 B2 7/2016 Baxter, III et al.
9,387,003 B2 7/2016 Kaercher et al.
9,393,015 B2 7/2016 Laurent et al.
9,393,017 B2 7/2016 Flanagan et al.
9,393,018 B2 7/2016 Wang et al.
9,398,911 B2 7/2016 Auld
D763,277 S 8/2016 Ahmed et al.
D764,498 S 8/2016 Capela et al.
9,402,604 B2 8/2016 Williams et al.
9,402,625 B2 8/2016 Coleman et al.
9,402,626 B2 8/2016 Ortiz et al.
9,402,627 B2 8/2016 Stevenson et al.
9,402,629 B2 8/2016 Ehrenfels et al.
9,408,604 B2 8/2016 Shelton, IV et al.
9,408,606 B2 8/2016 Shelton, IV
9,408,622 B2 8/2016 Stulen et al.
9,411,370 B2 8/2016 Benni et al.
9,413,128 B2 8/2016 Tien et al.
9,414,838 B2 8/2016 Shelton, IV et al.
9,414,849 B2 8/2016 Nagashimada
9,414,880 B2 8/2016 Monson et al.
9,420,967 B2 8/2016 Zand et al.
9,421,003 B2 8/2016 Williams et al.
9,421,014 B2 8/2016 Ingmanson et al.
9,421,030 B2 8/2016 Cole et al.
9,421,060 B2 8/2016 Monson et al.
9,421,062 B2 8/2016 Houser et al.
9,427,223 B2 8/2016 Park et al.
9,427,231 B2 8/2016 Racenet et al.
D767,624 S 9/2016 Lee et al.
9,433,411 B2 9/2016 Racenet et al.
9,433,419 B2 9/2016 Gonzalez et al.
9,433,420 B2 9/2016 Hodgkinson
9,439,649 B2 9/2016 Shelton, IV et al.
9,439,650 B2 9/2016 McGuckin, Jr. et al.
9,439,651 B2 9/2016 Smith et al.
9,439,668 B2 9/2016 Timm et al.
9,445,808 B2 9/2016 Woodard, Jr. et al.
9,445,813 B2 9/2016 Shelton, IV et al.
9,445,817 B2 9/2016 Bettuchi
9,446,226 B2 9/2016 Zilberman
9,451,938 B2 9/2016 Overes et al.
9,451,958 B2 9/2016 Shelton, IV et al.
D768,152 S 10/2016 Gutierrez et al.
D768,156 S 10/2016 Frincke
D769,315 S 10/2016 Scotti
D769,930 S 10/2016 Agrawal
9,461,340 B2 10/2016 Li et al.
9,463,040 B2 10/2016 Jeong et al.
9,463,260 B2 10/2016 Stopek
9,468,438 B2 10/2016 Baber et al.
9,468,447 B2 10/2016 Aman et al.
9,470,297 B2 10/2016 Aranyi et al.
9,471,969 B2 10/2016 Zeng et al.
9,474,506 B2 10/2016 Magnin et al.
9,474,523 B2 10/2016 Meade et al.
9,474,540 B2 10/2016 Stokes et al.
9,475,180 B2 10/2016 Eshleman et al.
D770,476 S 11/2016 Jitkoff et al.
D770,515 S 11/2016 Cho et al.
D771,116 S 11/2016 Dellinger et al.
D772,905 S 11/2016 Ingenlath
9,480,476 B2 11/2016 Aldridge et al.
9,480,492 B2 11/2016 Aranyi et al.
9,483,095 B2 11/2016 Tran et al.
9,486,186 B2 11/2016 Fiebig et al.
9,486,213 B2 11/2016 Altman et al.
9,486,214 B2 11/2016 Shelton, IV
9,486,302 B2 11/2016 Boey et al.
9,488,197 B2 11/2016 Wi
9,492,146 B2 11/2016 Kostrzewski et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,492,167 B2 11/2016 Shelton, IV et al.
9,492,170 B2 11/2016 Bear et al.
9,492,189 B2 11/2016 Williams et al.
9,492,192 B2 11/2016 To et al.
9,498,213 B2 11/2016 Marczyk et al.
9,498,219 B2 11/2016 Moore et al.
9,498,231 B2 11/2016 Haider et al.
9,504,483 B2 11/2016 Houser et al.
9,504,521 B2 11/2016 Deutmeyer et al.
D774,547 S 12/2016 Capela et al.
D775,336 S 12/2016 Shelton, IV et al.
9,510,827 B2 12/2016 Kostrzewski
9,510,828 B2 12/2016 Yates et al.
9,510,830 B2 12/2016 Shelton, IV et al.
9,510,846 B2 12/2016 Sholev et al.
9,510,895 B2 12/2016 Houser et al.
9,510,925 B2 12/2016 Hotter et al.
9,517,063 B2 12/2016 Swayze et al.
9,517,068 B2 12/2016 Shelton, IV et al.
9,521,996 B2 12/2016 Armstrong
9,522,029 B2 12/2016 Yates et al.
9,526,481 B2 12/2016 Storz et al.
9,526,499 B2 12/2016 Kostrzewski et al.
9,526,563 B2 12/2016 Twomey
9,526,564 B2 12/2016 Rusin
D776,683 S 1/2017 Gobinski et al.
D777,773 S 1/2017 Shi
9,532,783 B2 1/2017 Swayze et al.
9,539,726 B2 1/2017 Simaan et al.
9,545,253 B2 1/2017 Worrell et al.
9,545,258 B2 1/2017 Smith et al.
9,549,732 B2 1/2017 Yates et al.
9,549,735 B2 1/2017 Shelton, IV et al.
9,554,794 B2 1/2017 Baber et al.
9,554,796 B2 1/2017 Kostrzewski
9,554,812 B2 1/2017 Inkpen et al.
9,559,624 B2 1/2017 Philipp
9,561,013 B2 2/2017 Tsuchiya
9,561,030 B2 2/2017 Zhang et al.
9,561,031 B2 2/2017 Heinrich et al.
9,561,032 B2 2/2017 Shelton, IV et al.
9,561,038 B2 2/2017 Shelton, IV et al.
9,561,045 B2 2/2017 Hinman et al.
9,566,061 B2 2/2017 Aronhalt et al.
9,566,062 B2 2/2017 Boudreaux
9,566,065 B2 2/2017 Knodel
9,566,067 B2 2/2017 Milliman et al.
9,572,574 B2 2/2017 Shelton, IV et al.
9,572,577 B2 2/2017 Lloyd et al.
9,572,592 B2 2/2017 Price et al.
9,574,644 B2 2/2017 Parihar
9,579,088 B2 2/2017 Farritor et al.
D780,803 S 3/2017 Gill et al.
D781,879 S 3/2017 Butcher et al.
D782,530 S 3/2017 Paek et al.
9,585,550 B2 3/2017 Abel et al.
9,585,657 B2 3/2017 Shelton, IV et al.
9,585,658 B2 3/2017 Shelton, IV
9,585,659 B2 3/2017 Viola et al.
9,585,660 B2 3/2017 Laurent et al.
9,585,662 B2 3/2017 Shelton, IV et al.
9,585,663 B2 3/2017 Shelton, IV et al.
9,585,672 B2 3/2017 Bastia
9,590,433 B2 3/2017 Li
9,592,050 B2 3/2017 Schmid et al.
9,592,052 B2 3/2017 Shelton, IV
9,592,053 B2 3/2017 Shelton, IV et al.
9,592,054 B2 3/2017 Schmid et al.
9,597,073 B2 3/2017 Sorrentino et al.
9,597,075 B2 3/2017 Shelton, IV et al.
9,597,080 B2 3/2017 Milliman et al.
9,597,104 B2 3/2017 Nicholas et al.
9,597,143 B2 3/2017 Madan et al.
9,603,595 B2 3/2017 Shelton, IV et al.
9,603,598 B2 3/2017 Shelton, IV et al.
9,603,599 B2 3/2017 Miller et al.
9,603,991 B2 3/2017 Shelton, IV et al.
D783,658 S 4/2017 Hurst et al.
9,610,080 B2 4/2017 Whitfield et al.
9,614,258 B2 4/2017 Takahashi et al.
9,615,826 B2 4/2017 Shelton, IV et al.
9,622,745 B2 4/2017 Ingmanson et al.
9,629,623 B2 4/2017 Lytle, IV et al.
9,629,626 B2 4/2017 Soltz et al.
9,629,627 B2 4/2017 Kostrzewski et al.
9,629,628 B2 4/2017 Aranyi
9,629,629 B2 4/2017 Leimbach et al.
9,629,652 B2 4/2017 Mumaw et al.
9,629,814 B2 4/2017 Widenhouse et al.
D786,280 S 5/2017 Ma
D786,896 S 5/2017 Kim et al.
D787,547 S 5/2017 Basargin et al.
D788,123 S 5/2017 Shan et al.
D788,140 S 5/2017 Hemsley et al.
9,636,111 B2 5/2017 Wenchell
9,636,113 B2 5/2017 Wenchell
9,636,850 B2 5/2017 Stopek (Prommersberger) et al.
9,641,122 B2 5/2017 Romanowich et al.
9,642,620 B2 5/2017 Baxter, III et al.
9,649,096 B2 5/2017 Sholev
9,649,110 B2 5/2017 Parihar et al.
9,649,111 B2 5/2017 Shelton, IV et al.
9,655,613 B2 5/2017 Schaller
9,655,614 B2 5/2017 Swensgard et al.
9,655,615 B2 5/2017 Knodel et al.
9,655,616 B2 5/2017 Aranyi
9,655,624 B2 5/2017 Shelton, IV et al.
9,662,108 B2 5/2017 Williams
9,662,110 B2 5/2017 Huang et al.
9,662,116 B2 5/2017 Smith et al.
9,662,131 B2 5/2017 Omori et al.
D788,792 S 6/2017 Alessandri et al.
D789,384 S 6/2017 Lin et al.
D790,570 S 6/2017 Butcher et al.
9,668,728 B2 6/2017 Williams et al.
9,668,729 B2 6/2017 Williams et al.
9,668,732 B2 6/2017 Patel et al.
9,668,733 B2 6/2017 Williams
9,668,734 B2 6/2017 Kostrzewski et al.
9,675,344 B2 6/2017 Combrowski et al.
9,675,351 B2 6/2017 Hodgkinson et al.
9,675,354 B2 6/2017 Weir et al.
9,675,355 B2 6/2017 Shelton, IV et al.
9,675,372 B2 6/2017 Laurent et al.
9,675,375 B2 6/2017 Houser et al.
9,675,405 B2 6/2017 Trees et al.
9,675,819 B2 6/2017 Dunbar et al.
9,681,870 B2 6/2017 Baxter, III et al.
9,681,873 B2 6/2017 Smith et al.
9,681,884 B2 6/2017 Clem et al.
9,687,230 B2 6/2017 Leimbach et al.
9,687,231 B2 6/2017 Baxter, III et al.
9,687,232 B2 6/2017 Shelton, IV et al.
9,687,233 B2 6/2017 Fernandez et al.
9,687,236 B2 6/2017 Leimbach et al.
9,687,237 B2 6/2017 Schmid et al.
9,687,253 B2 6/2017 Detry et al.
9,689,466 B2 6/2017 Kanai et al.
9,690,362 B2 6/2017 Leimbach et al.
9,693,772 B2 7/2017 Ingmanson et al.
9,693,774 B2 7/2017 Gettinger et al.
9,693,777 B2 7/2017 Schellin et al.
9,700,309 B2 7/2017 Jaworek et al.
9,700,310 B2 7/2017 Morgan et al.
9,700,312 B2 7/2017 Kostrzewski et al.
9,700,317 B2 7/2017 Aronhalt et al.
9,700,318 B2 7/2017 Scirica et al.
9,700,319 B2 7/2017 Motooka et al.
9,700,320 B2 7/2017 Dinardo et al.
9,700,321 B2 7/2017 Shelton, IV et al.
9,706,981 B2 7/2017 Nicholas et al.
9,706,991 B2 7/2017 Hess et al.
9,706,993 B2 7/2017 Hessler et al.
9,707,005 B2 7/2017 Strobl et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,707,026 B2 7/2017 Malackowski et al.
9,707,043 B2 7/2017 Bozung
9,707,684 B2 7/2017 Ruiz Morales et al.
9,713,468 B2 7/2017 Harris et al.
9,713,470 B2 7/2017 Scirica et al.
9,713,474 B2 7/2017 Lorenz
9,717,497 B2 8/2017 Zerkle et al.
9,717,498 B2 8/2017 Aranyi et al.
9,722,236 B2 8/2017 Sathrum
9,724,091 B2 8/2017 Shelton, IV et al.
9,724,092 B2 8/2017 Baxter, III et al.
9,724,094 B2 8/2017 Baber et al.
9,724,096 B2 8/2017 Thompson et al.
9,724,098 B2 8/2017 Baxter, III et al.
9,724,118 B2 8/2017 Schulte et al.
9,724,163 B2 8/2017 Orban
9,730,692 B2 8/2017 Shelton, IV et al.
9,730,695 B2 8/2017 Leimbach et al.
9,730,697 B2 8/2017 Morgan et al.
9,730,717 B2 8/2017 Katsuki et al.
9,731,410 B2 8/2017 Hirabayashi et al.
9,733,663 B2 8/2017 Leimbach et al.
9,737,297 B2 8/2017 Racenet et al.
9,737,301 B2 8/2017 Baber et al.
9,737,302 B2 8/2017 Shelton, IV et al.
9,737,303 B2 8/2017 Shelton, IV et al.
9,737,365 B2 8/2017 Hegeman et al.
9,743,927 B2 8/2017 Whitman
9,743,928 B2 8/2017 Shelton, IV et al.
9,743,929 B2 8/2017 Leimbach et al.
D798,319 S 9/2017 Bergstrand et al.
9,750,498 B2 9/2017 Timm et al.
9,750,499 B2 9/2017 Leimbach et al.
9,750,501 B2 9/2017 Shelton, IV et al.
9,750,502 B2 9/2017 Scirica et al.
9,750,639 B2 9/2017 Barnes et al.
9,757,123 B2 9/2017 Giordano et al.
9,757,124 B2 9/2017 Schellin et al.
9,757,126 B2 9/2017 Cappola
9,757,128 B2 9/2017 Baber et al.
9,757,129 B2 9/2017 Williams
9,757,130 B2 9/2017 Shelton, IV
9,763,662 B2 9/2017 Shelton, IV et al.
9,763,668 B2 9/2017 Whitfield et al.
9,770,245 B2 9/2017 Swayze et al.
9,770,274 B2 9/2017 Pool et al.
D798,886 S 10/2017 Prophete et al.
D800,742 S 10/2017 Rhodes
D800,744 S 10/2017 Jitkoff et al.
D800,766 S 10/2017 Park et al.
D800,904 S 10/2017 Leimbach et al.
9,775,608 B2 10/2017 Aronhalt et al.
9,775,609 B2 10/2017 Shelton, IV et al.
9,775,610 B2 10/2017 Nicholas et al.
9,775,611 B2 10/2017 Kostrzewski
9,775,613 B2 10/2017 Shelton, IV et al.
9,775,614 B2 10/2017 Shelton, IV et al.
9,775,618 B2 10/2017 Bettuchi et al.
9,775,635 B2 10/2017 Takei
9,782,169 B2 10/2017 Kimsey et al.
9,782,170 B2 10/2017 Zemlok et al.
9,782,180 B2 10/2017 Smith et al.
9,782,193 B2 10/2017 Thistle
9,782,214 B2 10/2017 Houser et al.
9,788,834 B2 10/2017 Schmid et al.
9,788,835 B2 10/2017 Morgan et al.
9,788,836 B2 10/2017 Overmyer et al.
9,788,847 B2 10/2017 Jinno
9,788,851 B2 10/2017 Dannaher et al.
9,788,902 B2 10/2017 Inoue et al.
9,795,379 B2 10/2017 Leimbach et al.
9,795,380 B2 10/2017 Shelton, IV et al.
9,795,381 B2 10/2017 Shelton, IV
9,795,382 B2 10/2017 Shelton, IV
9,795,383 B2 10/2017 Aldridge et al.
9,795,384 B2 10/2017 Weaner et al.
9,797,486 B2 10/2017 Zergiebel et al.
9,801,626 B2 10/2017 Parihar et al.
9,801,627 B2 10/2017 Harris et al.
9,801,628 B2 10/2017 Harris et al.
9,801,634 B2 10/2017 Shelton, IV et al.
9,802,033 B2 10/2017 Hibner et al.
9,804,618 B2 10/2017 Leimbach et al.
D803,234 S 11/2017 Day et al.
D803,235 S 11/2017 Markson et al.
D803,850 S 11/2017 Chang et al.
9,808,244 B2 11/2017 Leimbach et al.
9,808,246 B2 11/2017 Shelton, IV et al.
9,808,247 B2 11/2017 Shelton, IV et al.
9,808,248 B2 11/2017 Hoffman
9,808,249 B2 11/2017 Shelton, IV
9,814,460 B2 11/2017 Kimsey et al.
9,814,462 B2 11/2017 Woodard, Jr. et al.
9,814,463 B2 11/2017 Williams et al.
9,814,530 B2 11/2017 Weir et al.
9,814,561 B2 11/2017 Forsell
9,820,445 B2 11/2017 Simpson et al.
9,820,737 B2 11/2017 Beardsley et al.
9,820,738 B2 11/2017 Lytle, IV et al.
9,820,741 B2 11/2017 Kostrzewski
9,820,768 B2 11/2017 Gee et al.
9,825,455 B2 11/2017 Sandhu et al.
9,826,976 B2 11/2017 Parihar et al.
9,826,977 B2 11/2017 Leimbach et al.
9,826,978 B2 11/2017 Shelton, IV et al.
9,829,698 B2 11/2017 Haraguchi et al.
D806,108 S 12/2017 Day
9,833,236 B2 12/2017 Shelton, IV et al.
9,833,238 B2 12/2017 Baxter, III et al.
9,833,239 B2 12/2017 Yates et al.
9,833,241 B2 12/2017 Huitema et al.
9,833,242 B2 12/2017 Baxter, III et al.
9,839,420 B2 12/2017 Shelton, IV et al.
9,839,421 B2 12/2017 Zerkle et al.
9,839,422 B2 12/2017 Schellin et al.
9,839,423 B2 12/2017 Vendely et al.
9,839,427 B2 12/2017 Swayze et al.
9,839,428 B2 12/2017 Baxter, III et al.
9,839,429 B2 12/2017 Weisenburgh, II et al.
9,839,480 B2 12/2017 Pribanic et al.
9,844,368 B2 12/2017 Boudreaux et al.
9,844,369 B2 12/2017 Huitema et al.
9,844,372 B2 12/2017 Shelton, IV et al.
9,844,373 B2 12/2017 Swayze et al.
9,844,374 B2 12/2017 Lytle, IV et al.
9,844,375 B2 12/2017 Overmyer et al.
9,844,376 B2 12/2017 Baxter, III et al.
9,844,379 B2 12/2017 Shelton, IV et al.
9,848,871 B2 12/2017 Harris et al.
9,848,873 B2 12/2017 Shelton, IV
9,848,875 B2 12/2017 Aronhalt et al.
9,848,877 B2 12/2017 Shelton, IV et al.
9,855,039 B2 1/2018 Racenet et al.
9,855,040 B2 1/2018 Kostrzewski
9,855,662 B2 1/2018 Ruiz Morales et al.
9,861,261 B2 1/2018 Shahinian
9,861,359 B2 1/2018 Shelton, IV et al.
9,861,361 B2 1/2018 Aronhalt et al.
9,861,362 B2 1/2018 Whitman et al.
9,861,382 B2 1/2018 Smith et al.
9,861,446 B2 1/2018 Lang
9,867,612 B2 1/2018 Parihar et al.
9,867,618 B2 1/2018 Hall et al.
9,867,620 B2 1/2018 Fischvogt et al.
9,868,198 B2 1/2018 Nicholas et al.
9,872,682 B2 1/2018 Hess et al.
9,872,683 B2 1/2018 Hopkins et al.
9,872,684 B2 1/2018 Hall et al.
9,877,721 B2 1/2018 Schellin et al.
9,877,723 B2 1/2018 Hall et al.
D810,099 S 2/2018 Riedel
9,883,843 B2 2/2018 Garlow
9,883,860 B2 2/2018 Leimbach et al.
9,883,861 B2 2/2018 Shelton, IV et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,884,456 B2 2/2018 Schellin et al.
9,888,919 B2 2/2018 Leimbach et al.
9,888,921 B2 2/2018 Williams et al.
9,888,924 B2 2/2018 Ebersole et al.
9,889,230 B2 2/2018 Bennett et al.
9,895,147 B2 2/2018 Shelton, IV
9,895,148 B2 2/2018 Shelton, IV et al.
9,895,813 B2 2/2018 Blumenkranz et al.
9,901,339 B2 2/2018 Farascioni
9,901,341 B2 2/2018 Kostrzewski
9,901,342 B2 2/2018 Shelton, IV et al.
9,901,344 B2 2/2018 Moore et al.
9,901,345 B2 2/2018 Moore et al.
9,901,346 B2 2/2018 Moore et al.
9,901,406 B2 2/2018 State et al.
9,901,412 B2 2/2018 Lathrop et al.
D813,899 S 3/2018 Erant et al.
9,907,456 B2 3/2018 Miyoshi
9,907,553 B2 3/2018 Cole et al.
9,907,600 B2 3/2018 Stulen et al.
9,907,620 B2 3/2018 Shelton, IV et al.
9,913,642 B2 3/2018 Leimbach et al.
9,913,644 B2 3/2018 McCuen
9,913,646 B2 3/2018 Shelton, IV
9,913,647 B2 3/2018 Weisenburgh, II et al.
9,913,648 B2 3/2018 Shelton, IV et al.
9,913,694 B2 3/2018 Brisson
9,913,733 B2 3/2018 Piron et al.
9,918,704 B2 3/2018 Shelton, IV et al.
9,918,714 B2 3/2018 Gibbons, Jr.
9,918,715 B2 3/2018 Menn
9,918,716 B2 3/2018 Baxter, III et al.
9,918,717 B2 3/2018 Czernik
9,924,941 B2 3/2018 Burbank
9,924,942 B2 3/2018 Swayze et al.
9,924,944 B2 3/2018 Shelton, IV et al.
9,924,945 B2 3/2018 Zheng et al.
9,924,946 B2 3/2018 Vendely et al.
9,924,947 B2 3/2018 Shelton, IV et al.
9,924,961 B2 3/2018 Shelton, IV et al.
9,931,106 B2 4/2018 Au et al.
9,931,116 B2 4/2018 Racenet et al.
9,931,118 B2 4/2018 Shelton, IV et al.
9,936,949 B2 4/2018 Measamer et al.
9,936,950 B2 4/2018 Shelton, IV et al.
9,936,951 B2 4/2018 Hufnagel et al.
9,936,954 B2 4/2018 Shelton, IV et al.
9,937,626 B2 4/2018 Rockrohr
9,943,309 B2 4/2018 Shelton, IV et al.
9,943,310 B2 4/2018 Harris et al.
9,943,312 B2 4/2018 Posada et al.
D819,072 S 5/2018 Clediere
9,955,954 B2 5/2018 Destoumieux et al.
9,955,965 B2 5/2018 Chen et al.
9,955,966 B2 5/2018 Zergiebel
9,962,158 B2 5/2018 Hall et al.
9,962,159 B2 5/2018 Heinrich et al.
9,962,161 B2 5/2018 Scheib et al.
9,968,354 B2 5/2018 Shelton, IV et al.
9,968,355 B2 5/2018 Shelton, IV et al.
9,968,356 B2 5/2018 Shelton, IV et al.
9,968,397 B2 5/2018 Taylor et al.
9,974,529 B2 5/2018 Shelton, IV et al.
9,974,538 B2 5/2018 Baxter, III et al.
9,974,539 B2 5/2018 Yates et al.
9,974,541 B2 5/2018 Calderoni
9,974,542 B2 5/2018 Hodgkinson
9,980,713 B2 5/2018 Aronhalt et al.
9,980,724 B2 5/2018 Farascioni et al.
9,980,729 B2 5/2018 Moore et al.
9,980,769 B2 5/2018 Trees et al.
D819,680 S 6/2018 Nguyen
D819,682 S 6/2018 Howard et al.
D819,684 S 6/2018 Dart
D820,307 S 6/2018 Jian et al.
D820,867 S 6/2018 Dickens et al.
9,987,000 B2 6/2018 Shelton, IV et al.
9,987,003 B2 6/2018 Timm et al.
9,987,006 B2 6/2018 Morgan et al.
9,987,095 B2 6/2018 Chowaniec et al.
9,987,099 B2 6/2018 Chen et al.
9,993,248 B2 6/2018 Shelton, IV et al.
9,993,258 B2 6/2018 Shelton, IV et al.
9,999,408 B2 6/2018 Boudreaux et al.
9,999,423 B2 6/2018 Schuckmann et al.
9,999,426 B2 6/2018 Moore et al.
9,999,431 B2 6/2018 Shelton, IV et al.
9,999,472 B2 6/2018 Weir et al.
10,004,497 B2 6/2018 Overmyer et al.
10,004,498 B2 6/2018 Morgan et al.
10,004,500 B2 6/2018 Shelton, IV et al.
10,004,501 B2 6/2018 Shelton, IV et al.
10,004,505 B2 6/2018 Moore et al.
10,004,506 B2 6/2018 Shelton, IV et al.
D822,206 S 7/2018 Shelton, IV et al.
10,010,322 B2 7/2018 Shelton, IV et al.
10,010,324 B2 7/2018 Huitema et al.
10,013,049 B2 7/2018 Leimbach et al.
10,016,199 B2 7/2018 Baber et al.
10,022,125 B2 7/2018 (Prommersberger) Stopek et al.
10,024,407 B2 7/2018 Aranyi et al.
10,028,742 B2 7/2018 Shelton, IV et al.
10,028,743 B2 7/2018 Shelton, IV et al.
10,028,744 B2 7/2018 Shelton, IV et al.
10,028,761 B2 7/2018 Leimbach et al.
10,029,125 B2 7/2018 Shapiro et al.
10,034,344 B2 7/2018 Yoshida
10,034,668 B2 7/2018 Ebner
D826,405 S 8/2018 Shelton, IV et al.
10,039,440 B2 8/2018 Fenech et al.
10,039,529 B2 8/2018 Kerr et al.
10,039,532 B2 8/2018 Srinivas et al.
10,039,545 B2 8/2018 Sadowski et al.
10,041,822 B2 8/2018 Zemlok
10,045,769 B2 8/2018 Aronhalt et al.
10,045,776 B2 8/2018 Shelton, IV et al.
10,045,778 B2 8/2018 Yates et al.
10,045,779 B2 8/2018 Savage et al.
10,045,781 B2 8/2018 Cropper et al.
10,052,044 B2 8/2018 Shelton, IV et al.
10,052,099 B2 8/2018 Morgan et al.
10,052,100 B2 8/2018 Morgan et al.
10,052,102 B2 8/2018 Baxter, III et al.
10,052,104 B2 8/2018 Shelton, IV et al.
10,052,164 B2 8/2018 Overmyer
10,058,317 B2 8/2018 Fan et al.
10,058,327 B2 8/2018 Weisenburgh, II et al.
10,058,395 B2 8/2018 Devengenzo et al.
10,058,963 B2 8/2018 Shelton, IV et al.
10,064,620 B2 9/2018 Gettinger et al.
10,064,621 B2 9/2018 Kerr et al.
10,064,624 B2 9/2018 Shelton, IV et al.
10,064,639 B2 9/2018 Ishida et al.
10,064,649 B2 9/2018 Golebieski et al.
10,064,688 B2 9/2018 Shelton, IV et al.
10,070,861 B2 9/2018 Spivey et al.
10,070,863 B2 9/2018 Swayze et al.
10,071,452 B2 9/2018 Shelton, IV et al.
10,076,325 B2 9/2018 Huang et al.
10,076,326 B2 9/2018 Yates et al.
10,076,340 B2 9/2018 Belagali et al.
D831,209 S 10/2018 Huitema et al.
D831,676 S 10/2018 Park et al.
D832,301 S 10/2018 Smith
10,085,624 B2 10/2018 Isoda et al.
10,085,643 B2 10/2018 Bandic et al.
10,085,728 B2 10/2018 Jogasaki et al.
10,085,748 B2 10/2018 Morgan et al.
10,085,749 B2 10/2018 Cappola et al.
10,085,751 B2 10/2018 Overmyer et al.
10,085,754 B2 10/2018 Sniffin et al.
10,085,806 B2 10/2018 Hagn et al.
10,092,292 B2 10/2018 Boudreaux et al.
10,098,635 B2 10/2018 Burbank

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,098,636 B2 10/2018 Shelton, IV et al.
10,098,638 B2 10/2018 Viola et al.
10,098,640 B2 10/2018 Bertolero et al.
10,098,642 B2 10/2018 Baxter, III et al.
10,099,303 B2 10/2018 Yoshida et al.
10,101,861 B2 10/2018 Kiyoto
10,105,128 B2 10/2018 Cooper et al.
10,105,136 B2 10/2018 Yates et al.
10,105,139 B2 10/2018 Yates et al.
10,105,140 B2 10/2018 Malinouskas et al.
10,106,932 B2 10/2018 Anderson et al.
10,111,657 B2 10/2018 McCuen
10,111,679 B2 10/2018 Baber et al.
10,111,698 B2 10/2018 Scheib et al.
10,111,702 B2 10/2018 Kostrzewski
10,117,649 B2 11/2018 Baxter, III et al.
10,117,652 B2 11/2018 Schmid et al.
10,117,653 B2 11/2018 Leimbach et al.
10,117,654 B2 11/2018 Ingmanson et al.
10,123,798 B2 11/2018 Baxter, III et al.
10,124,493 B2 11/2018 Rothfuss et al.
10,130,352 B2 11/2018 Widenhouse et al.
10,130,359 B2 11/2018 Hess et al.
10,130,361 B2 11/2018 Yates et al.
10,130,363 B2 11/2018 Huitema et al.
10,130,366 B2 11/2018 Shelton, IV et al.
10,130,367 B2 11/2018 Cappola et al.
10,130,738 B2 11/2018 Shelton, IV et al.
10,130,830 B2 11/2018 Miret Carceller et al.
10,133,248 B2 11/2018 Fitzsimmons et al.
10,135,242 B2 11/2018 Baber et al.
10,136,887 B2 11/2018 Shelton, IV et al.
10,136,889 B2 11/2018 Shelton, IV et al.
10,136,890 B2 11/2018 Shelton, IV et al.
10,136,891 B2 11/2018 Shelton, IV et al.
D835,659 S 12/2018 Anzures et al.
D836,124 S 12/2018 Fan
10,143,474 B2 12/2018 Bucciaglia et al.
10,149,679 B2 12/2018 Shelton, IV et al.
10,149,680 B2 12/2018 Parihar et al.
10,149,682 B2 12/2018 Shelton, IV et al.
10,149,683 B2 12/2018 Smith et al.
10,149,712 B2 12/2018 Manwaring et al.
10,154,841 B2 12/2018 Weaner et al.
10,159,482 B2 12/2018 Swayze et al.
10,159,483 B2 12/2018 Beckman et al.
10,163,589 B2 12/2018 Zergiebel et al.
D837,244 S 1/2019 Kuo et al.
D837,245 S 1/2019 Kuo et al.
10,166,025 B2 1/2019 Leimbach et al.
10,166,026 B2 1/2019 Shelton, IV et al.
10,172,611 B2 1/2019 Shelton, IV et al.
10,172,615 B2 1/2019 Marczyk et al.
10,172,616 B2 1/2019 Murray et al.
10,172,617 B2 1/2019 Shelton, IV et al.
10,172,619 B2 1/2019 Harris et al.
10,172,620 B2 1/2019 Harris et al.
10,172,636 B2 1/2019 Stulen et al.
10,175,127 B2 1/2019 Collins et al.
10,178,992 B2 1/2019 Wise et al.
10,180,463 B2 1/2019 Beckman et al.
10,182,813 B2 1/2019 Leimbach et al.
10,182,815 B2 1/2019 Williams et al.
10,182,816 B2 1/2019 Shelton, IV et al.
10,182,818 B2 1/2019 Hensel et al.
10,182,819 B2 1/2019 Shelton, IV
10,188,385 B2 1/2019 Kerr et al.
10,188,393 B2 1/2019 Smith et al.
10,188,394 B2 1/2019 Shelton, IV et al.
D839,900 S 2/2019 Gan
D841,667 S 2/2019 Coren
10,194,801 B2 2/2019 Elhawary et al.
10,194,904 B2 2/2019 Viola et al.
10,194,907 B2 2/2019 Marczyk et al.
10,194,910 B2 2/2019 Shelton, IV et al.
10,194,913 B2 2/2019 Nalagatla et al.
10,194,976 B2 2/2019 Boudreaux
10,201,348 B2 2/2019 Scheib et al.
10,201,349 B2 2/2019 Leimbach et al.
10,201,363 B2 2/2019 Shelton, IV
10,201,364 B2 2/2019 Leimbach et al.
10,201,365 B2 2/2019 Boudreaux et al.
10,201,381 B2 2/2019 Zergiebel et al.
10,206,605 B2 2/2019 Shelton, IV et al.
10,206,676 B2 2/2019 Shelton, IV
10,206,677 B2 2/2019 Harris et al.
10,206,678 B2 2/2019 Shelton, IV et al.
10,210,244 B1 2/2019 Branavan et al.
10,211,586 B2 2/2019 Adams et al.
10,213,198 B2 2/2019 Aronhalt et al.
10,213,201 B2 2/2019 Shelton, IV et al.
10,213,202 B2 2/2019 Flanagan et al.
10,213,203 B2 2/2019 Swayze et al.
10,213,262 B2 2/2019 Shelton, IV et al.
D842,328 S 3/2019 Jian et al.
10,219,811 B2 3/2019 Haider et al.
10,219,832 B2 3/2019 Bagwell et al.
10,220,522 B2 3/2019 Rockrohr
10,226,239 B2 3/2019 Nicholas et al.
10,226,249 B2 3/2019 Jaworek et al.
10,226,250 B2 3/2019 Beckman et al.
10,226,251 B2 3/2019 Scheib et al.
10,226,274 B2 3/2019 Worrell et al.
10,231,634 B2 3/2019 Zand et al.
10,231,653 B2 3/2019 Bohm et al.
10,231,734 B2 3/2019 Thompson et al.
10,231,794 B2 3/2019 Shelton, IV et al.
10,238,385 B2 3/2019 Yates et al.
10,238,386 B2 3/2019 Overmyer et al.
10,238,387 B2 3/2019 Yates et al.
10,238,389 B2 3/2019 Yates et al.
10,238,390 B2 3/2019 Harris et al.
10,238,391 B2 3/2019 Leimbach et al.
D844,666 S 4/2019 Espeleta et al.
D844,667 S 4/2019 Espeleta et al.
D845,342 S 4/2019 Espeleta et al.
10,245,027 B2 4/2019 Shelton, IV et al.
10,245,028 B2 4/2019 Shelton, IV et al.
10,245,029 B2 4/2019 Hunter et al.
10,245,030 B2 4/2019 Hunter et al.
10,245,032 B2 4/2019 Shelton, IV
10,245,033 B2 4/2019 Overmyer et al.
10,245,034 B2 4/2019 Shelton, IV et al.
10,245,035 B2 4/2019 Swayze et al.
10,245,058 B2 4/2019 Omori et al.
10,251,648 B2 4/2019 Harris et al.
10,251,649 B2 4/2019 Schellin et al.
10,251,725 B2 4/2019 Valentine et al.
10,258,322 B2 4/2019 Fanton et al.
10,258,330 B2 4/2019 Shelton, IV et al.
10,258,331 B2 4/2019 Shelton, IV et al.
10,258,332 B2 4/2019 Schmid et al.
10,258,333 B2 4/2019 Shelton, IV et al.
10,258,336 B2 4/2019 Baxter, III et al.
10,258,418 B2 4/2019 Shelton, IV et al.
10,264,797 B2 4/2019 Zhang et al.
10,265,065 B2 4/2019 Shelton, IV et al.
10,265,067 B2 4/2019 Yates et al.
10,265,068 B2 4/2019 Harris et al.
10,265,072 B2 4/2019 Shelton, IV et al.
10,265,073 B2 4/2019 Scheib et al.
10,265,074 B2 4/2019 Shelton, IV et al.
10,265,090 B2 4/2019 Ingmanson et al.
10,271,844 B2 4/2019 Valentine et al.
10,271,845 B2 4/2019 Shelton, IV
10,271,846 B2 4/2019 Shelton, IV et al.
10,271,849 B2 4/2019 Vendely et al.
10,271,851 B2 4/2019 Shelton, IV et al.
D847,989 S 5/2019 Shelton, IV et al.
D848,473 S 5/2019 Zhu et al.
D849,046 S 5/2019 Kuo et al.
10,278,696 B2 5/2019 Gurumurthy et al.
10,278,697 B2 5/2019 Shelton, IV et al.
10,278,702 B2 5/2019 Shelton, IV et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,278,703 B2 5/2019 Nativ et al.
10,278,707 B2 5/2019 Thompson et al.
10,278,722 B2 5/2019 Shelton, IV et al.
10,278,780 B2 5/2019 Shelton, IV
10,285,694 B2 5/2019 Viola et al.
10,285,695 B2 5/2019 Jaworek et al.
10,285,699 B2 5/2019 Vendely et al.
10,285,705 B2 5/2019 Shelton, IV et al.
10,292,701 B2 5/2019 Scheib et al.
10,292,704 B2 5/2019 Harris et al.
10,292,707 B2 5/2019 Shelton, IV et al.
10,293,100 B2 5/2019 Shelton, IV et al.
10,293,553 B2 5/2019 Racenet et al.
10,299,787 B2 5/2019 Shelton, IV
10,299,788 B2 5/2019 Heinrich et al.
10,299,792 B2 5/2019 Huitema et al.
10,299,817 B2 5/2019 Shelton, IV et al.
10,299,818 B2 5/2019 Riva
10,299,878 B2 5/2019 Shelton, IV et al.
D850,617 S 6/2019 Shelton, IV et al.
D851,676 S 6/2019 Foss et al.
D851,762 S 6/2019 Shelton, IV et al.
10,307,159 B2 6/2019 Harris et al.
10,307,160 B2 6/2019 Vendely et al.
10,307,161 B2 6/2019 Jankowski
10,307,163 B2 6/2019 Moore et al.
10,307,170 B2 6/2019 Parfett et al.
10,307,202 B2 6/2019 Smith et al.
10,314,559 B2 6/2019 Razzaque et al.
10,314,577 B2 6/2019 Laurent et al.
10,314,582 B2 6/2019 Shelton, IV et al.
10,314,587 B2 6/2019 Harris et al.
10,314,588 B2 6/2019 Turner et al.
10,314,589 B2 6/2019 Shelton, IV et al.
10,314,590 B2 6/2019 Shelton, IV et al.
10,315,566 B2 6/2019 Choi et al.
10,321,907 B2 6/2019 Shelton, IV et al.
10,321,909 B2 6/2019 Shelton, IV et al.
10,321,927 B2 6/2019 Hinman
10,327,743 B2 6/2019 St. Goar et al.
10,327,764 B2 6/2019 Harris et al.
10,327,765 B2 6/2019 Timm et al.
10,327,767 B2 6/2019 Shelton, IV et al.
10,327,769 B2 6/2019 Overmyer et al.
10,327,776 B2 6/2019 Harris et al.
10,327,777 B2 6/2019 Harris et al.
D854,032 S 7/2019 Jones et al.
D854,151 S 7/2019 Shelton, IV et al.
10,335,144 B2 7/2019 Shelton, IV et al.
10,335,145 B2 7/2019 Harris et al.
10,335,147 B2 7/2019 Rector et al.
10,335,148 B2 7/2019 Shelton, IV et al.
10,335,149 B2 7/2019 Baxter, III et al.
10,335,150 B2 7/2019 Shelton, IV
10,335,151 B2 7/2019 Shelton, IV et al.
10,337,148 B2 7/2019 Rouse et al.
10,342,533 B2 7/2019 Shelton, IV et al.
10,342,535 B2 7/2019 Scheib et al.
10,342,541 B2 7/2019 Shelton, IV et al.
10,342,543 B2 7/2019 Shelton, IV et al.
10,342,623 B2 7/2019 Huelman et al.
10,349,939 B2 7/2019 Shelton, IV et al.
10,357,246 B2 7/2019 Shelton, IV et al.
10,357,247 B2 7/2019 Shelton, IV et al.
10,357,248 B2 7/2019 Dalessandro et al.
10,357,252 B2 7/2019 Harris et al.
10,363,031 B2 7/2019 Alexander, III et al.
10,363,033 B2 7/2019 Timm et al.
10,363,036 B2 7/2019 Yates et al.
10,363,037 B2 7/2019 Aronhalt et al.
10,363,045 B2 7/2019 Whitfield et al.
D855,634 S 8/2019 Kim
D856,359 S 8/2019 Huang et al.
10,368,838 B2 8/2019 Williams et al.
10,368,861 B2 8/2019 Baxter, III et al.
10,368,863 B2 8/2019 Timm et al.
10,368,864 B2 8/2019 Harris et al.
10,368,865 B2 8/2019 Harris et al.
10,368,867 B2 8/2019 Harris et al.
10,368,892 B2 8/2019 Stulen et al.
10,376,262 B2 8/2019 Zemlok et al.
10,376,263 B2 8/2019 Morgan et al.
10,383,626 B2 8/2019 Soltz
10,383,628 B2 8/2019 Kang et al.
10,383,629 B2 8/2019 Ross et al.
10,383,630 B2 8/2019 Shelton, IV et al.
10,383,633 B2 8/2019 Shelton, IV et al.
10,383,634 B2 8/2019 Shelton, IV et al.
10,390,823 B2 8/2019 Shelton, IV et al.
10,390,825 B2 8/2019 Shelton, IV et al.
10,390,828 B2 8/2019 Vendely et al.
10,390,829 B2 8/2019 Eckert et al.
10,390,830 B2 8/2019 Schulz
10,390,841 B2 8/2019 Shelton, IV et al.
10,390,897 B2 8/2019 Kostrzewski
D860,219 S 9/2019 Rasmussen et al.
10,398,433 B2 9/2019 Boudreaux et al.
10,398,434 B2 9/2019 Shelton, IV et al.
10,398,436 B2 9/2019 Shelton, IV et al.
10,405,854 B2 9/2019 Schmid et al.
10,405,857 B2 9/2019 Shelton, IV et al.
10,405,859 B2 9/2019 Harris et al.
10,405,863 B2 9/2019 Wise et al.
10,405,914 B2 9/2019 Manwaring et al.
10,405,932 B2 9/2019 Overmyer
10,413,291 B2 9/2019 Worthington et al.
10,413,293 B2 9/2019 Shelton, IV et al.
10,413,294 B2 9/2019 Shelton, IV et al.
10,413,297 B2 9/2019 Harris et al.
10,413,370 B2 9/2019 Yates et al.
10,413,373 B2 9/2019 Yates et al.
10,420,548 B2 9/2019 Whitman et al.
10,420,549 B2 9/2019 Yates et al.
10,420,550 B2 9/2019 Shelton, IV
10,420,552 B2 9/2019 Shelton, IV et al.
10,420,553 B2 9/2019 Shelton, IV et al.
10,420,555 B2 9/2019 Shelton, IV et al.
10,420,558 B2 9/2019 Nalagatla et al.
10,420,559 B2 9/2019 Marczyk et al.
10,420,560 B2 9/2019 Shelton, IV et al.
10,420,561 B2 9/2019 Shelton, IV et al.
10,420,577 B2 9/2019 Chowaniec et al.
D861,707 S 10/2019 Yang
10,426,463 B2 10/2019 Shelton, IV et al.
10,426,467 B2 10/2019 Miller et al.
10,426,468 B2 10/2019 Contini et al.
10,426,469 B2 10/2019 Shelton, IV et al.
10,426,471 B2 10/2019 Shelton, IV et al.
10,426,476 B2 10/2019 Harris et al.
10,426,477 B2 10/2019 Harris et al.
10,426,478 B2 10/2019 Shelton, IV et al.
10,426,481 B2 10/2019 Aronhalt et al.
10,433,837 B2 10/2019 Worthington et al.
10,433,839 B2 10/2019 Scheib et al.
10,433,840 B2 10/2019 Shelton, IV et al.
10,433,844 B2 10/2019 Shelton, IV et al.
10,433,845 B2 10/2019 Baxter, III et al.
10,433,846 B2 10/2019 Vendely et al.
10,433,849 B2 10/2019 Shelton, IV et al.
10,433,918 B2 10/2019 Shelton, IV et al.
10,441,279 B2 10/2019 Shelton, IV et al.
10,441,280 B2 10/2019 Timm et al.
10,441,281 B2 10/2019 Shelton, IV et al.
10,441,285 B2 10/2019 Shelton, IV et al.
10,441,286 B2 10/2019 Shelton, IV et al.
10,441,345 B2 10/2019 Aldridge et al.
10,441,369 B2 10/2019 Shelton, IV et al.
10,448,948 B2 10/2019 Shelton, IV et al.
10,448,950 B2 10/2019 Shelton, IV et al.
10,448,952 B2 10/2019 Shelton, IV et al.
10,456,122 B2 10/2019 Koltz et al.
10,456,132 B2 10/2019 Gettinger et al.
10,456,133 B2 10/2019 Yates et al.
10,456,137 B2 10/2019 Vendely et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,456,140 B2 10/2019 Shelton, IV et al.
10,463,367 B2 11/2019 Kostrzewski et al.
10,463,369 B2 11/2019 Shelton, IV et al.
10,463,370 B2 11/2019 Yates et al.
10,463,372 B2 11/2019 Shelton, IV et al.
10,463,373 B2 11/2019 Mozdzierz et al.
10,463,382 B2 11/2019 Ingmanson et al.
10,463,383 B2 11/2019 Shelton, IV et al.
10,463,384 B2 11/2019 Shelton, IV et al.
10,470,762 B2 11/2019 Leimbach et al.
10,470,763 B2 11/2019 Yates et al.
10,470,764 B2 11/2019 Baxter, III et al.
10,470,768 B2 11/2019 Harris et al.
10,470,769 B2 11/2019 Shelton, IV et al.
10,471,576 B2 11/2019 Totsu
10,471,607 B2 11/2019 Butt et al.
10,582,928 B2 * 3/2020 Hunter A61B 17/07207
2001/0000531 A1 4/2001 Casscells et al.
2001/0025183 A1 9/2001 Shahidi
2001/0025184 A1 9/2001 Messerly
2001/0034530 A1 10/2001 Malackowski et al.
2002/0014510 A1 2/2002 Richter et al.
2002/0022810 A1 2/2002 Urich
2002/0022836 A1 2/2002 Goble et al.
2002/0022861 A1 2/2002 Jacobs et al.
2002/0029032 A1 3/2002 Arkin
2002/0029036 A1 3/2002 Goble et al.
2002/0042620 A1 4/2002 Julian et al.
2002/0087048 A1 7/2002 Brock et al.
2002/0091374 A1 7/2002 Cooper
2002/0095175 A1 7/2002 Brock et al.
2002/0103494 A1 8/2002 Pacey
2002/0116063 A1 8/2002 Giannetti et al.
2002/0117534 A1 8/2002 Green et al.
2002/0127265 A1 9/2002 Bowman et al.
2002/0128633 A1 9/2002 Brock et al.
2002/0134811 A1 9/2002 Napier et al.
2002/0135474 A1 9/2002 Sylliassen
2002/0143340 A1 10/2002 Kaneko
2002/0158593 A1 10/2002 Henderson et al.
2002/0185514 A1 12/2002 Adams et al.
2002/0188170 A1 12/2002 Santamore et al.
2002/0188287 A1 12/2002 Zvuloni et al.
2003/0009193 A1 1/2003 Corsaro
2003/0011245 A1 1/2003 Fiebig
2003/0012805 A1 1/2003 Chen et al.
2003/0045835 A1 3/2003 Anderson et al.
2003/0066858 A1 4/2003 Holgersson
2003/0078647 A1 4/2003 Vallana et al.
2003/0083648 A1 5/2003 Wang et al.
2003/0084983 A1 5/2003 Rangachari et al.
2003/0093103 A1 5/2003 Malackowski et al.
2003/0094356 A1 5/2003 Waldron
2003/0096158 A1 5/2003 Takano et al.
2003/0114851 A1 6/2003 Truckai et al.
2003/0121586 A1 7/2003 Mitra et al.
2003/0139741 A1 7/2003 Goble et al.
2003/0149406 A1 8/2003 Martineau et al.
2003/0153908 A1 8/2003 Goble et al.
2003/0153968 A1 8/2003 Geis et al.
2003/0163085 A1 8/2003 Tanner et al.
2003/0164172 A1 9/2003 Chumas et al.
2003/0181900 A1 9/2003 Long
2003/0190584 A1 10/2003 Heasley
2003/0195387 A1 10/2003 Kortenbach et al.
2003/0205029 A1 11/2003 Chapolini et al.
2003/0212005 A1 11/2003 Petito et al.
2003/0216732 A1 11/2003 Truckai et al.
2003/0236505 A1 12/2003 Bonadio et al.
2004/0006335 A1 1/2004 Garrison
2004/0006340 A1 1/2004 Latterell et al.
2004/0007608 A1 1/2004 Ehrenfels et al.
2004/0024457 A1 2/2004 Boyce et al.
2004/0028502 A1 2/2004 Cummins
2004/0030333 A1 2/2004 Goble
2004/0034357 A1 2/2004 Beane et al.
2004/0044295 A1 3/2004 Reinert et al.
2004/0044364 A1 3/2004 DeVries et al.
2004/0049121 A1 3/2004 Yaron
2004/0049172 A1 3/2004 Root et al.
2004/0059362 A1 3/2004 Knodel et al.
2004/0068161 A1 4/2004 Couvillon
2004/0068224 A1 4/2004 Couvillon et al.
2004/0068307 A1 4/2004 Goble
2004/0070369 A1 4/2004 Sakakibara
2004/0073222 A1 4/2004 Koseki
2004/0078037 A1 4/2004 Batchelor et al.
2004/0082952 A1 4/2004 Dycus et al.
2004/0085180 A1 5/2004 Juang
2004/0093024 A1 5/2004 Lousararian et al.
2004/0098040 A1 5/2004 Taniguchi et al.
2004/0101822 A1 5/2004 Wiesner et al.
2004/0102783 A1 5/2004 Sutterlin et al.
2004/0108357 A1 6/2004 Milliman et al.
2004/0110439 A1 6/2004 Chaikof et al.
2004/0115022 A1 6/2004 Albertson et al.
2004/0116952 A1 6/2004 Sakurai et al.
2004/0119185 A1 6/2004 Chen
2004/0122419 A1 6/2004 Neuberger
2004/0122423 A1 6/2004 Dycus et al.
2004/0133095 A1 7/2004 Dunki-Jacobs et al.
2004/0133189 A1 7/2004 Sakurai
2004/0143297 A1 7/2004 Ramsey
2004/0147909 A1 7/2004 Johnston et al.
2004/0153100 A1 8/2004 Ahlberg et al.
2004/0158261 A1 8/2004 Vu
2004/0164123 A1 8/2004 Racenet et al.
2004/0166169 A1 8/2004 Malaviya et al.
2004/0167572 A1 8/2004 Roth et al.
2004/0181219 A1 9/2004 Goble et al.
2004/0193189 A1 9/2004 Kortenbach et al.
2004/0197367 A1 10/2004 Rezania et al.
2004/0199181 A1 10/2004 Knodel et al.
2004/0204735 A1 10/2004 Shiroff et al.
2004/0218451 A1 11/2004 Said et al.
2004/0222268 A1 11/2004 Bilotti et al.
2004/0225186 A1 11/2004 Horne et al.
2004/0232201 A1 11/2004 Wenchell et al.
2004/0236352 A1 11/2004 Wang et al.
2004/0243147 A1 12/2004 Lipow
2004/0243151 A1 12/2004 Demmy et al.
2004/0243163 A1 12/2004 Casiano et al.
2004/0247415 A1 12/2004 Mangone
2004/0249366 A1 12/2004 Kunz
2004/0254455 A1 12/2004 Iddan
2004/0254566 A1 12/2004 Plicchi et al.
2004/0254590 A1 12/2004 Hoffman et al.
2004/0260315 A1 12/2004 Dell et al.
2004/0267310 A1 12/2004 Racenet et al.
2005/0010158 A1 1/2005 Brugger et al.
2005/0010213 A1 1/2005 Stad et al.
2005/0021078 A1 1/2005 Vleugels et al.
2005/0032511 A1 2/2005 Malone et al.
2005/0033352 A1 2/2005 Zepf et al.
2005/0051163 A1 3/2005 Deem et al.
2005/0054946 A1 3/2005 Krzyzanowski
2005/0057225 A1 3/2005 Marquet
2005/0058890 A1 3/2005 Brazell et al.
2005/0059997 A1 3/2005 Bauman et al.
2005/0070929 A1 3/2005 Dalessandro et al.
2005/0075561 A1 4/2005 Golden
2005/0080342 A1 4/2005 Gilreath et al.
2005/0085693 A1 4/2005 Belson et al.
2005/0090817 A1 4/2005 Phan
2005/0096683 A1 5/2005 Ellins et al.
2005/0116673 A1 6/2005 Carl et al.
2005/0124855 A1 6/2005 Jaffe et al.
2005/0125897 A1 6/2005 Wyslucha et al.
2005/0130682 A1 6/2005 Takara et al.
2005/0131173 A1 6/2005 McDaniel et al.
2005/0131211 A1 6/2005 Bayley et al.
2005/0131390 A1 6/2005 Heinrich et al.
2005/0131436 A1 6/2005 Johnston et al.
2005/0131457 A1 6/2005 Douglas et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0137454 A1 6/2005 Saadat et al.
2005/0137455 A1 6/2005 Ewers et al.
2005/0139636 A1 6/2005 Schwemberger et al.
2005/0143759 A1 6/2005 Kelly
2005/0143769 A1 6/2005 White et al.
2005/0145671 A1 7/2005 Viola
2005/0150928 A1 7/2005 Kameyama et al.
2005/0154258 A1 7/2005 Tartaglia et al.
2005/0154406 A1 7/2005 Bombard et al.
2005/0159778 A1 7/2005 Heinrich et al.
2005/0165419 A1 7/2005 Sauer et al.
2005/0169974 A1 8/2005 Tenerz et al.
2005/0171522 A1 8/2005 Christopherson
2005/0177176 A1 8/2005 Gerbi et al.
2005/0177181 A1 8/2005 Kagan et al.
2005/0177249 A1 8/2005 Kladakis et al.
2005/0182298 A1 8/2005 Ikeda et al.
2005/0182443 A1 8/2005 Jonn et al.
2005/0184121 A1 8/2005 Heinrich
2005/0186240 A1 8/2005 Ringeisen et al.
2005/0187545 A1 8/2005 Hooven et al.
2005/0203550 A1 9/2005 Laufer et al.
2005/0209614 A1 9/2005 Fenter et al.
2005/0216055 A1 9/2005 Scirica et al.
2005/0222587 A1 10/2005 Jinno et al.
2005/0222611 A1 10/2005 Weitkamp
2005/0222616 A1 10/2005 Rethy et al.
2005/0222665 A1 10/2005 Aranyi
2005/0228224 A1 10/2005 Okada et al.
2005/0228446 A1 10/2005 Mooradian et al.
2005/0230453 A1 10/2005 Viola
2005/0240178 A1 10/2005 Morley et al.
2005/0245965 A1 11/2005 Orban, III et al.
2005/0246881 A1 11/2005 Kelly et al.
2005/0251063 A1 11/2005 Basude
2005/0256452 A1 11/2005 DeMarchi et al.
2005/0261676 A1 11/2005 Hall et al.
2005/0263563 A1 12/2005 Racenet et al.
2005/0267455 A1 12/2005 Eggers et al.
2005/0274034 A1 12/2005 Hayashida et al.
2005/0283188 A1 12/2005 Loshakove et al.
2006/0008787 A1 1/2006 Hayman et al.
2006/0015009 A1 1/2006 Jaffe et al.
2006/0020258 A1 1/2006 Strauss et al.
2006/0020336 A1 1/2006 Liddicoat
2006/0025812 A1 2/2006 Shelton
2006/0041188 A1 2/2006 Dirusso et al.
2006/0047275 A1 3/2006 Goble
2006/0049229 A1 3/2006 Milliman et al.
2006/0052824 A1 3/2006 Ransick et al.
2006/0052825 A1 3/2006 Ransick et al.
2006/0064086 A1 3/2006 Odom
2006/0079735 A1 4/2006 Martone et al.
2006/0079879 A1 4/2006 Faller et al.
2006/0086032 A1 4/2006 Valencic et al.
2006/0087746 A1 4/2006 Lipow
2006/0089535 A1 4/2006 Raz et al.
2006/0097699 A1 5/2006 Kamenoff
2006/0100643 A1 5/2006 Laufer et al.
2006/0100649 A1 5/2006 Hart
2006/0111711 A1 5/2006 Goble
2006/0111723 A1 5/2006 Chapolini et al.
2006/0116634 A1 6/2006 Shachar
2006/0142772 A1 6/2006 Ralph et al.
2006/0154546 A1 7/2006 Murphy et al.
2006/0161050 A1 7/2006 Butler et al.
2006/0161185 A1 7/2006 Saadat et al.
2006/0167471 A1 7/2006 Phillips
2006/0173290 A1 8/2006 Lavallee et al.
2006/0173470 A1 8/2006 Oray et al.
2006/0176031 A1 8/2006 Forman et al.
2006/0178556 A1 8/2006 Nasser et al.
2006/0180633 A1 8/2006 Emmons
2006/0180634 A1 8/2006 Shelton et al.
2006/0185682 A1 8/2006 Marczyk
2006/0199999 A1 9/2006 Ikeda et al.
2006/0201989 A1 9/2006 Ojeda
2006/0206100 A1 9/2006 Eskridge et al.
2006/0217729 A1 9/2006 Eskridge et al.
2006/0235368 A1 10/2006 Oz
2006/0241666 A1 10/2006 Briggs et al.
2006/0244460 A1 11/2006 Weaver
2006/0252990 A1 11/2006 Kubach
2006/0252993 A1 11/2006 Freed et al.
2006/0258904 A1 11/2006 Stefanchik et al.
2006/0259073 A1 11/2006 Miyamoto et al.
2006/0261763 A1 11/2006 Iott et al.
2006/0263444 A1 11/2006 Ming et al.
2006/0264831 A1 11/2006 Skwarek et al.
2006/0264929 A1 11/2006 Goble et al.
2006/0271042 A1 11/2006 Latterell et al.
2006/0271102 A1 11/2006 Bosshard et al.
2006/0282064 A1 12/2006 Shimizu et al.
2006/0284730 A1 12/2006 Schmid et al.
2006/0287576 A1 12/2006 Tsuji et al.
2006/0289602 A1 12/2006 Wales et al.
2006/0291981 A1 12/2006 Viola et al.
2007/0009570 A1 1/2007 Kim et al.
2007/0010702 A1 1/2007 Wang et al.
2007/0010838 A1 1/2007 Shelton et al.
2007/0016235 A1 1/2007 Tanaka et al.
2007/0026039 A1 2/2007 Drumheller et al.
2007/0026040 A1 2/2007 Crawley et al.
2007/0027468 A1 2/2007 Wales et al.
2007/0027551 A1 2/2007 Farnsworth et al.
2007/0043387 A1 2/2007 Vargas et al.
2007/0049951 A1 3/2007 Menn
2007/0049966 A1 3/2007 Bonadio et al.
2007/0051375 A1 3/2007 Milliman
2007/0055228 A1 3/2007 Berg et al.
2007/0073341 A1 3/2007 Smith et al.
2007/0073389 A1 3/2007 Bolduc et al.
2007/0078328 A1 4/2007 Ozaki et al.
2007/0078484 A1 4/2007 Talarico et al.
2007/0084897 A1 4/2007 Shelton et al.
2007/0088376 A1 4/2007 Zacharias
2007/0090788 A1 4/2007 Hansford et al.
2007/0093869 A1 4/2007 Bloom et al.
2007/0102472 A1 5/2007 Shelton
2007/0106113 A1 5/2007 Ravo
2007/0106317 A1 5/2007 Shelton et al.
2007/0134251 A1 6/2007 Ashkenazi et al.
2007/0135686 A1 6/2007 Pruitt et al.
2007/0135803 A1 6/2007 Belson
2007/0152612 A1 7/2007 Chen et al.
2007/0155010 A1 7/2007 Farnsworth et al.
2007/0170225 A1 7/2007 Shelton et al.
2007/0173687 A1 7/2007 Shima et al.
2007/0173813 A1 7/2007 Odom
2007/0175950 A1 8/2007 Shelton et al.
2007/0175951 A1 8/2007 Shelton et al.
2007/0175955 A1 8/2007 Shelton et al.
2007/0179477 A1 8/2007 Danger
2007/0185545 A1 8/2007 Duke
2007/0187857 A1 8/2007 Riley et al.
2007/0190110 A1 8/2007 Pameijer et al.
2007/0191868 A1 8/2007 Theroux et al.
2007/0194079 A1 8/2007 Hueil et al.
2007/0194082 A1 8/2007 Morgan et al.
2007/0197954 A1 8/2007 Keenan
2007/0198039 A1 8/2007 Jones et al.
2007/0203510 A1 8/2007 Bettuchi
2007/0207010 A1 9/2007 Caspi
2007/0208359 A1 9/2007 Hoffman
2007/0208375 A1 9/2007 Nishizawa et al.
2007/0213750 A1 9/2007 Weadock
2007/0225562 A1 9/2007 Spivey et al.
2007/0233163 A1 10/2007 Bombard et al.
2007/0243227 A1 10/2007 Gertner
2007/0244471 A1 10/2007 Malackowski
2007/0246505 A1 10/2007 Pace-Floridia et al.
2007/0262592 A1 11/2007 Hwang et al.
2007/0275035 A1 11/2007 Herman et al.
2007/0276409 A1 11/2007 Ortiz et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0279011 A1 12/2007 Jones et al.
2007/0286892 A1 12/2007 Herzberg et al.
2007/0296286 A1 12/2007 Avenell
2008/0003196 A1 1/2008 Jonn et al.
2008/0015598 A1 1/2008 Prommersberger
2008/0021486 A1 1/2008 Oyola et al.
2008/0029570 A1 2/2008 Shelton et al.
2008/0029573 A1 2/2008 Shelton et al.
2008/0029574 A1 2/2008 Shelton et al.
2008/0029575 A1 2/2008 Shelton et al.
2008/0030170 A1 2/2008 Dacquay et al.
2008/0039746 A1 2/2008 Hissong et al.
2008/0042861 A1 2/2008 Dacquay et al.
2008/0051833 A1 2/2008 Gramuglia et al.
2008/0064921 A1 3/2008 Larkin et al.
2008/0065153 A1 3/2008 Allard et al.
2008/0071328 A1 3/2008 Haubrich et al.
2008/0078802 A1 4/2008 Hess et al.
2008/0082114 A1 4/2008 McKenna et al.
2008/0082125 A1 4/2008 Murray et al.
2008/0082126 A1 4/2008 Murray et al.
2008/0083807 A1 4/2008 Beardsley et al.
2008/0085296 A1 4/2008 Powell et al.
2008/0086078 A1 4/2008 Powell et al.
2008/0091072 A1 4/2008 Omori et al.
2008/0108443 A1 5/2008 Jinno et al.
2008/0114250 A1 5/2008 Urbano et al.
2008/0125634 A1 5/2008 Ryan et al.
2008/0125749 A1 5/2008 Olson
2008/0128469 A1 6/2008 Dalessandro et al.
2008/0129253 A1 6/2008 Shiue et al.
2008/0135600 A1 6/2008 Hiranuma et al.
2008/0140115 A1 6/2008 Stopek
2008/0140159 A1 6/2008 Bornhoft et al.
2008/0154299 A1 6/2008 Livneh
2008/0154335 A1 6/2008 Thrope et al.
2008/0169328 A1 7/2008 Shelton
2008/0169332 A1 7/2008 Shelton et al.
2008/0169333 A1 7/2008 Shelton et al.
2008/0172087 A1 7/2008 Fuchs et al.
2008/0177392 A1 7/2008 Williams et al.
2008/0190989 A1 8/2008 Crews et al.
2008/0196253 A1 8/2008 Ezra et al.
2008/0196419 A1 8/2008 Dube
2008/0197167 A1 8/2008 Viola et al.
2008/0200755 A1 8/2008 Bakos
2008/0200762 A1 8/2008 Stokes et al.
2008/0200835 A1 8/2008 Monson et al.
2008/0200911 A1 8/2008 Long
2008/0200933 A1 8/2008 Bakos et al.
2008/0200934 A1 8/2008 Fox
2008/0206186 A1 8/2008 Butler et al.
2008/0234709 A1 9/2008 Houser
2008/0242939 A1 10/2008 Johnston
2008/0249536 A1 10/2008 Stahler et al.
2008/0249608 A1 10/2008 Dave
2008/0255413 A1 10/2008 Zemlok et al.
2008/0262654 A1 10/2008 Omori et al.
2008/0269596 A1 10/2008 Revie et al.
2008/0281171 A1 11/2008 Fennell et al.
2008/0287944 A1 11/2008 Pearson et al.
2008/0293910 A1 11/2008 Kapiamba et al.
2008/0294179 A1 11/2008 Balbierz et al.
2008/0296346 A1 12/2008 Shelton, IV et al.
2008/0297287 A1 12/2008 Shachar et al.
2008/0308602 A1 12/2008 Timm et al.
2008/0308603 A1 12/2008 Shelton et al.
2008/0312687 A1 12/2008 Blier
2008/0315829 A1 12/2008 Jones et al.
2009/0001121 A1 1/2009 Hess et al.
2009/0001130 A1 1/2009 Hess et al.
2009/0004455 A1 1/2009 Gravagna et al.
2009/0005809 A1 1/2009 Hess et al.
2009/0012534 A1 1/2009 Madhani et al.
2009/0015195 A1 1/2009 Loth-Krausser
2009/0020958 A1 1/2009 Soul
2009/0048583 A1 2/2009 Williams et al.
2009/0048589 A1 2/2009 Takashino et al.
2009/0076506 A1 3/2009 Baker
2009/0078736 A1 3/2009 Van Lue
2009/0081313 A1 3/2009 Aghion et al.
2009/0088659 A1 4/2009 Graham et al.
2009/0090763 A1 4/2009 Zemlok et al.
2009/0092651 A1 4/2009 Shah et al.
2009/0099579 A1 4/2009 Nentwick et al.
2009/0099876 A1 4/2009 Whitman
2009/0112234 A1 4/2009 Crainich et al.
2009/0118762 A1 5/2009 Crainch et al.
2009/0119011 A1 5/2009 Kondo et al.
2009/0131819 A1 5/2009 Ritchie et al.
2009/0132400 A1 5/2009 Conway
2009/0143855 A1 6/2009 Weber et al.
2009/0149871 A9 6/2009 Kagan et al.
2009/0171147 A1 7/2009 Lee et al.
2009/0177226 A1 7/2009 Reinprecht et al.
2009/0181290 A1 7/2009 Baldwin et al.
2009/0188964 A1 7/2009 Orlov
2009/0192534 A1 7/2009 Ortiz et al.
2009/0198272 A1 8/2009 Kerver et al.
2009/0204108 A1 8/2009 Steffen
2009/0204109 A1 8/2009 Grove et al.
2009/0206125 A1 8/2009 Huitema et al.
2009/0206126 A1 8/2009 Huitema et al.
2009/0206131 A1 8/2009 Weisenburgh, II et al.
2009/0206133 A1 8/2009 Morgan et al.
2009/0206137 A1 8/2009 Hall et al.
2009/0206139 A1 8/2009 Hall et al.
2009/0206141 A1 8/2009 Huitema et al.
2009/0206142 A1 8/2009 Huitema et al.
2009/0221993 A1 9/2009 Sohi et al.
2009/0227834 A1 9/2009 Nakamoto et al.
2009/0234273 A1 9/2009 Intoccia et al.
2009/0242610 A1 10/2009 Shelton, IV et al.
2009/0247368 A1 10/2009 Chiang
2009/0247901 A1 10/2009 Zimmer
2009/0253959 A1 10/2009 Yoshie et al.
2009/0255974 A1 10/2009 Viola
2009/0262078 A1 10/2009 Pizzi
2009/0270895 A1 10/2009 Churchill et al.
2009/0290016 A1 11/2009 Suda
2009/0292283 A1 11/2009 Odom
2009/0306639 A1 12/2009 Nevo et al.
2009/0308907 A1 12/2009 Nalagatla et al.
2009/0318557 A1 12/2009 Stockel
2009/0325859 A1 12/2009 Ameer et al.
2010/0005035 A1 1/2010 Carpenter et al.
2010/0012703 A1 1/2010 Calabrese et al.
2010/0015104 A1 1/2010 Fraser et al.
2010/0016888 A1 1/2010 Calabrese et al.
2010/0017715 A1 1/2010 Balassanian
2010/0023024 A1 1/2010 Zeiner et al.
2010/0030233 A1 2/2010 Whitman et al.
2010/0036370 A1 2/2010 Mirel et al.
2010/0051668 A1 3/2010 Milliman et al.
2010/0057118 A1 3/2010 Dietz et al.
2010/0065604 A1 3/2010 Weng
2010/0069942 A1 3/2010 Shelton, IV
2010/0076483 A1 3/2010 Imuta
2010/0076489 A1 3/2010 Stopek et al.
2010/0081883 A1 4/2010 Murray et al.
2010/0094340 A1 4/2010 Stopek et al.
2010/0100123 A1 4/2010 Bennett
2010/0100124 A1 4/2010 Calabrese et al.
2010/0116519 A1 5/2010 Gareis
2010/0122339 A1 5/2010 Boccacci
2010/0133317 A1 6/2010 Shelton, IV et al.
2010/0137990 A1 6/2010 Apatsidis et al.
2010/0145146 A1 6/2010 Melder
2010/0147921 A1 6/2010 Olson
2010/0147922 A1 6/2010 Olson
2010/0179022 A1 7/2010 Shirokoshi
2010/0180711 A1 7/2010 Kilibarda et al.
2010/0191262 A1 7/2010 Harris et al.
2010/0191292 A1 7/2010 DeMeo et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0193566 A1 8/2010 Scheib et al.
2010/0204717 A1 8/2010 Knodel
2010/0204721 A1 8/2010 Young et al.
2010/0217281 A1 8/2010 Matsuoka et al.
2010/0222901 A1 9/2010 Swayze et al.
2010/0241137 A1 9/2010 Doyle et al.
2010/0249497 A1 9/2010 Peine et al.
2010/0249947 A1 9/2010 Lesh et al.
2010/0256675 A1 10/2010 Romans
2010/0258327 A1 10/2010 Esenwein et al.
2010/0267662 A1 10/2010 Fielder et al.
2010/0274160 A1 10/2010 Yachi et al.
2010/0292540 A1 11/2010 Hess et al.
2010/0298636 A1 11/2010 Castro et al.
2010/0301097 A1 12/2010 Scirica et al.
2010/0310623 A1 12/2010 Laurencin et al.
2010/0312261 A1 12/2010 Suzuki et al.
2010/0318085 A1 12/2010 Austin et al.
2010/0331856 A1 12/2010 Carlson et al.
2011/0006101 A1 1/2011 Hall et al.
2011/0011916 A1 1/2011 Levine
2011/0016960 A1 1/2011 Debrailly
2011/0021871 A1 1/2011 Berkelaar
2011/0022032 A1 1/2011 Zemlok et al.
2011/0024477 A1 2/2011 Hall
2011/0024478 A1 2/2011 Shelton, IV
2011/0025311 A1 2/2011 Chauvin et al.
2011/0036891 A1 2/2011 Zemlok et al.
2011/0046667 A1 2/2011 Culligan et al.
2011/0052660 A1 3/2011 Yang et al.
2011/0060363 A1 3/2011 Hess et al.
2011/0066156 A1 3/2011 McGahan et al.
2011/0082538 A1 4/2011 Dahlgren et al.
2011/0087276 A1 4/2011 Bedi et al.
2011/0088921 A1 4/2011 Forgues et al.
2011/0091515 A1 4/2011 Zilberman et al.
2011/0095064 A1 4/2011 Taylor et al.
2011/0101069 A1 5/2011 Bombard et al.
2011/0101794 A1 5/2011 Schroeder et al.
2011/0112517 A1 5/2011 Peine et al.
2011/0112530 A1 5/2011 Keller
2011/0114697 A1 5/2011 Baxter, III et al.
2011/0121049 A1 5/2011 Malinouskas et al.
2011/0125176 A1 5/2011 Yates et al.
2011/0127945 A1 6/2011 Yoneda
2011/0129706 A1 6/2011 Takahashi et al.
2011/0144764 A1 6/2011 Bagga et al.
2011/0147433 A1 6/2011 Shelton, IV et al.
2011/0160725 A1 6/2011 Kabaya et al.
2011/0163146 A1 7/2011 Ortiz et al.
2011/0172495 A1 7/2011 Armstrong
2011/0174861 A1 7/2011 Shelton, IV et al.
2011/0192882 A1 8/2011 Hess et al.
2011/0199225 A1 8/2011 Touchberry et al.
2011/0218400 A1 9/2011 Ma et al.
2011/0218550 A1 9/2011 Ma
2011/0230713 A1 9/2011 Kleemann et al.
2011/0238044 A1 9/2011 Main et al.
2011/0241597 A1 10/2011 Zhu et al.
2011/0271186 A1 11/2011 Owens
2011/0275901 A1 11/2011 Shelton, IV
2011/0276083 A1 11/2011 Shelton, IV et al.
2011/0278343 A1 11/2011 Knodel et al.
2011/0279268 A1 11/2011 Konishi et al.
2011/0290856 A1 12/2011 Shelton, IV et al.
2011/0293690 A1 12/2011 Griffin et al.
2011/0295295 A1 12/2011 Shelton, IV et al.
2011/0313894 A1 12/2011 Dye et al.
2011/0315413 A1 12/2011 Fisher et al.
2012/0004636 A1 1/2012 Lo
2012/0007442 A1 1/2012 Rhodes et al.
2012/0016239 A1 1/2012 Barthe et al.
2012/0016413 A1 1/2012 Timm et al.
2012/0016467 A1 1/2012 Chen et al.
2012/0029272 A1 2/2012 Shelton, IV et al.
2012/0033360 A1 2/2012 Hsu
2012/0059286 A1 3/2012 Hastings et al.
2012/0064483 A1 3/2012 Lint et al.
2012/0074200 A1 3/2012 Schmid et al.
2012/0078244 A1 3/2012 Worrell et al.
2012/0080336 A1 4/2012 Shelton, IV et al.
2012/0080344 A1 4/2012 Shelton, IV
2012/0080478 A1 4/2012 Morgan et al.
2012/0080498 A1 4/2012 Shelton, IV et al.
2012/0086276 A1 4/2012 Sawyers
2012/0095458 A1 4/2012 Cybulski et al.
2012/0109186 A1 5/2012 Parrott et al.
2012/0116261 A1 5/2012 Mumaw et al.
2012/0116262 A1 5/2012 Houser et al.
2012/0116265 A1 5/2012 Houser et al.
2012/0116266 A1 5/2012 Houser et al.
2012/0118595 A1 5/2012 Pellenc
2012/0123463 A1 5/2012 Jacobs
2012/0125792 A1 5/2012 Cassivi
2012/0130217 A1 5/2012 Kauphusman et al.
2012/0132286 A1 5/2012 Lim et al.
2012/0171539 A1 7/2012 Rejman et al.
2012/0175398 A1 7/2012 Sandborn et al.
2012/0197272 A1 8/2012 Oray et al.
2012/0211542 A1 8/2012 Racenet
2012/0234895 A1 9/2012 O'Connor et al.
2012/0234897 A1 9/2012 Shelton, IV et al.
2012/0239068 A1 9/2012 Morris et al.
2012/0248169 A1 10/2012 Widenhouse et al.
2012/0251861 A1 10/2012 Liang et al.
2012/0253328 A1 10/2012 Cunningham et al.
2012/0283707 A1 11/2012 Giordano et al.
2012/0289811 A1 11/2012 Viola et al.
2012/0289979 A1 11/2012 Eskaros et al.
2012/0292367 A1 11/2012 Morgan et al.
2012/0298722 A1 11/2012 Hess et al.
2012/0303002 A1 11/2012 Chowaniec et al.
2013/0006227 A1 1/2013 Takashino
2013/0008937 A1 1/2013 Viola
2013/0012983 A1 1/2013 Kleyman
2013/0018400 A1 1/2013 Milton et al.
2013/0020375 A1 1/2013 Shelton, IV et al.
2013/0020376 A1 1/2013 Shelton, IV et al.
2013/0023861 A1 1/2013 Shelton, IV et al.
2013/0023910 A1 1/2013 Solomon et al.
2013/0026208 A1 1/2013 Shelton, IV et al.
2013/0026210 A1 1/2013 Shelton, IV et al.
2013/0030462 A1 1/2013 Keating et al.
2013/0041292 A1 2/2013 Cunningham
2013/0057162 A1 3/2013 Pollischansky
2013/0068816 A1 3/2013 Mandakolathur Vasudevan et al.
2013/0087597 A1 4/2013 Shelton, IV et al.
2013/0090534 A1 4/2013 Burns et al.
2013/0096568 A1 4/2013 Justis
2013/0098970 A1 4/2013 Racenet et al.
2013/0105552 A1 5/2013 Weir et al.
2013/0106352 A1 5/2013 Nagamine
2013/0116669 A1 5/2013 Shelton, IV et al.
2013/0123816 A1 5/2013 Hodgkinson et al.
2013/0126202 A1 5/2013 Oomori et al.
2013/0131476 A1 5/2013 Siu et al.
2013/0131651 A1 5/2013 Strobl et al.
2013/0136969 A1 5/2013 Yasui et al.
2013/0153641 A1 6/2013 Shelton, IV et al.
2013/0158390 A1 6/2013 Tan et al.
2013/0162198 A1 6/2013 Yokota et al.
2013/0169217 A1 7/2013 Watanabe et al.
2013/0172878 A1 7/2013 Smith
2013/0175317 A1 7/2013 Yates et al.
2013/0214025 A1 8/2013 Zemlok et al.
2013/0233906 A1 9/2013 Hess et al.
2013/0238021 A1 9/2013 Gross et al.
2013/0248578 A1 9/2013 Arteaga Gonzalez
2013/0253480 A1 9/2013 Kimball et al.
2013/0256373 A1 10/2013 Schmid et al.
2013/0256380 A1 10/2013 Schmid et al.
2013/0267978 A1 10/2013 Trissel
2013/0270322 A1 10/2013 Scheib et al.
2013/0277410 A1 10/2013 Fernandez et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2013/0306704 A1 11/2013 Balbierz et al.
2013/0317753 A1 11/2013 Kamen et al.
2013/0324982 A1 12/2013 Smith et al.
2013/0327552 A1 12/2013 Lovelass et al.
2013/0333910 A1 12/2013 Tanimoto et al.
2013/0334280 A1 12/2013 Krehel et al.
2013/0334283 A1 12/2013 Swayze et al.
2013/0334285 A1 12/2013 Swayze et al.
2013/0341374 A1 12/2013 Shelton, IV et al.
2014/0001231 A1 1/2014 Shelton, IV et al.
2014/0001234 A1 1/2014 Shelton, IV et al.
2014/0005640 A1 1/2014 Shelton, IV et al.
2014/0005678 A1 1/2014 Shelton, IV et al.
2014/0005702 A1 1/2014 Timm et al.
2014/0005718 A1 1/2014 Shelton, IV et al.
2014/0012289 A1 1/2014 Snow et al.
2014/0012299 A1 1/2014 Stoddard et al.
2014/0014705 A1 1/2014 Baxter, III
2014/0018832 A1 1/2014 Shelton, IV
2014/0039549 A1 2/2014 Belsky et al.
2014/0048580 A1 2/2014 Merchant et al.
2014/0081176 A1 3/2014 Hassan
2014/0094681 A1 4/2014 Valentine et al.
2014/0100558 A1 4/2014 Schmitz et al.
2014/0107640 A1 4/2014 Yates et al.
2014/0110456 A1 4/2014 Taylor
2014/0115229 A1 4/2014 Kothamasu et al.
2014/0131418 A1 5/2014 Kostrzewski
2014/0135832 A1 5/2014 Park et al.
2014/0151433 A1 6/2014 Shelton, IV et al.
2014/0158747 A1 6/2014 Measamer et al.
2014/0166723 A1 6/2014 Beardsley et al.
2014/0166724 A1 6/2014 Schellin et al.
2014/0166725 A1 6/2014 Schellin et al.
2014/0166726 A1 6/2014 Schellin et al.
2014/0175147 A1 6/2014 Manoux et al.
2014/0175150 A1 6/2014 Shelton, IV et al.
2014/0175152 A1 6/2014 Hess et al.
2014/0181710 A1 6/2014 Baalu et al.
2014/0188091 A1 7/2014 Vidal et al.
2014/0188159 A1 7/2014 Steege
2014/0207124 A1 7/2014 Aldridge et al.
2014/0207125 A1 7/2014 Applegate et al.
2014/0209658 A1 7/2014 Skalla et al.
2014/0224857 A1 8/2014 Schmid
2014/0228867 A1 8/2014 Thomas et al.
2014/0239047 A1 8/2014 Hodgkinson et al.
2014/0243865 A1 8/2014 Swayze et al.
2014/0246475 A1 9/2014 Hall et al.
2014/0248167 A1 9/2014 Sugimoto et al.
2014/0249557 A1 9/2014 Koch, Jr. et al.
2014/0249573 A1 9/2014 Arav
2014/0252061 A1 9/2014 Estrella et al.
2014/0263541 A1 9/2014 Leimbach et al.
2014/0263552 A1 9/2014 Hall et al.
2014/0263558 A1 9/2014 Hausen et al.
2014/0276730 A1 9/2014 Boudreaux et al.
2014/0284371 A1 9/2014 Morgan et al.
2014/0288460 A1 9/2014 Ouyang et al.
2014/0291379 A1 10/2014 Schellin et al.
2014/0291383 A1 10/2014 Spivey et al.
2014/0299648 A1 10/2014 Shelton, IV et al.
2014/0303645 A1 10/2014 Morgan et al.
2014/0303660 A1 10/2014 Boyden et al.
2014/0330161 A1 11/2014 Swayze et al.
2014/0330298 A1 11/2014 Arshonsky et al.
2014/0330579 A1 11/2014 Cashman et al.
2014/0367445 A1 12/2014 Ingmanson et al.
2014/0374130 A1 12/2014 Nakamura et al.
2014/0378950 A1 12/2014 Chiu
2015/0002089 A1 1/2015 Rejman et al.
2015/0008248 A1 1/2015 Giordano et al.
2015/0038961 A1 2/2015 Clark et al.
2015/0053737 A1 2/2015 Leimbach et al.
2015/0053742 A1 2/2015 Shelton, IV et al.
2015/0053743 A1 2/2015 Yates et al.
2015/0053746 A1 2/2015 Shelton, IV et al.
2015/0053748 A1 2/2015 Yates et al.
2015/0060518 A1 3/2015 Shelton, IV et al.
2015/0060519 A1 3/2015 Shelton, IV et al.
2015/0060520 A1 3/2015 Shelton, IV et al.
2015/0060521 A1 3/2015 Weisenburgh, II et al.
2015/0066000 A1 3/2015 An et al.
2015/0076208 A1 3/2015 Shelton, IV
2015/0076209 A1 3/2015 Shelton, IV et al.
2015/0076210 A1 3/2015 Shelton, IV et al.
2015/0076212 A1 3/2015 Shelton, IV
2015/0080868 A1 3/2015 Kerr
2015/0083781 A1 3/2015 Giordano et al.
2015/0083782 A1 3/2015 Scheib et al.
2015/0088547 A1 3/2015 Balram et al.
2015/0090760 A1 4/2015 Giordano et al.
2015/0090761 A1 4/2015 Giordano et al.
2015/0090762 A1 4/2015 Giordano et al.
2015/0122870 A1 5/2015 Zemlok et al.
2015/0134077 A1 5/2015 Shelton, IV et al.
2015/0150620 A1 6/2015 Miyamoto et al.
2015/0173749 A1 6/2015 Shelton, IV et al.
2015/0173756 A1 6/2015 Baxter, III et al.
2015/0173789 A1 6/2015 Baxter, III et al.
2015/0196295 A1 7/2015 Shelton, IV et al.
2015/0196296 A1 7/2015 Swayze et al.
2015/0196299 A1 7/2015 Swayze et al.
2015/0201918 A1 7/2015 Kumar et al.
2015/0201932 A1 7/2015 Swayze et al.
2015/0201936 A1 7/2015 Swayze et al.
2015/0201937 A1 7/2015 Swayze et al.
2015/0201938 A1 7/2015 Swayze et al.
2015/0201939 A1 7/2015 Swayze et al.
2015/0201940 A1 7/2015 Swayze et al.
2015/0201941 A1 7/2015 Swayze et al.
2015/0222212 A1 8/2015 Iwata
2015/0223868 A1 8/2015 Brandt et al.
2015/0231409 A1 8/2015 Racenet et al.
2015/0238118 A1 8/2015 Legassey et al.
2015/0272557 A1 10/2015 Overmyer et al.
2015/0272571 A1 10/2015 Leimbach et al.
2015/0272580 A1 10/2015 Leimbach et al.
2015/0272582 A1 10/2015 Leimbach et al.
2015/0297200 A1 10/2015 Fitzsimmons et al.
2015/0297222 A1 10/2015 Huitema et al.
2015/0297223 A1 10/2015 Huitema et al.
2015/0297225 A1 10/2015 Huitema et al.
2015/0297228 A1 10/2015 Huitema et al.
2015/0297229 A1 10/2015 Schellin et al.
2015/0297233 A1 10/2015 Huitema et al.
2015/0297234 A1 10/2015 Schellin et al.
2015/0302539 A1 10/2015 Mazar et al.
2015/0303417 A1 10/2015 Koeder et al.
2015/0313594 A1 11/2015 Shelton, IV et al.
2015/0324317 A1 11/2015 Collins et al.
2015/0327864 A1 11/2015 Hodgkinson et al.
2015/0336249 A1 11/2015 Iwata et al.
2015/0352699 A1 12/2015 Sakai et al.
2015/0366585 A1 12/2015 Lemay et al.
2015/0372265 A1 12/2015 Morisaku et al.
2015/0374369 A1 12/2015 Yates et al.
2015/0374371 A1 12/2015 Richard et al.
2015/0374372 A1 12/2015 Zergiebel et al.
2015/0374378 A1 12/2015 Giordano et al.
2016/0000430 A1 1/2016 Ming et al.
2016/0000431 A1 1/2016 Giordano et al.
2016/0000437 A1 1/2016 Giordano et al.
2016/0000438 A1 1/2016 Swayze et al.
2016/0000442 A1 1/2016 Shelton, IV
2016/0000452 A1 1/2016 Yates et al.
2016/0000453 A1 1/2016 Yates et al.
2016/0023342 A1 1/2016 Koenig et al.
2016/0030042 A1 2/2016 Heinrich et al.
2016/0058443 A1 3/2016 Yates et al.
2016/0066815 A1 3/2016 Mei et al.
2016/0066913 A1 3/2016 Swayze et al.
2016/0069449 A1 3/2016 Kanai et al.
2016/0074040 A1 3/2016 Widenhouse et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0074103 A1 3/2016 Sartor
2016/0082161 A1 3/2016 Zilberman et al.
2016/0089137 A1 3/2016 Hess et al.
2016/0089198 A1 3/2016 Arya et al.
2016/0095585 A1 4/2016 Zergiebel et al.
2016/0106431 A1 4/2016 Shelton, IV et al.
2016/0113653 A1 4/2016 Zingman
2016/0120544 A1 5/2016 Shelton, IV et al.
2016/0120545 A1 5/2016 Shelton, IV et al.
2016/0120594 A1 5/2016 Privitera
2016/0135835 A1 5/2016 Onuma
2016/0166248 A1 6/2016 Deville et al.
2016/0166256 A1 6/2016 Baxter, III et al.
2016/0174974 A1 6/2016 Schmid et al.
2016/0183939 A1 6/2016 Shelton, IV et al.
2016/0183943 A1 6/2016 Shelton, IV
2016/0183944 A1 6/2016 Swensgard et al.
2016/0192916 A1 7/2016 Shelton, IV et al.
2016/0192917 A1 7/2016 Shelton, IV et al.
2016/0192918 A1 7/2016 Shelton, IV et al.
2016/0192960 A1 7/2016 Bueno et al.
2016/0192977 A1 7/2016 Manwaring et al.
2016/0199063 A1 7/2016 Mandakolathur Vasudevan et al.
2016/0199089 A1 7/2016 Hess et al.
2016/0199956 A1 7/2016 Shelton, IV et al.
2016/0206310 A1 7/2016 Shelton, IV
2016/0206314 A1 7/2016 Scheib et al.
2016/0235404 A1 8/2016 Shelton, IV
2016/0235409 A1 8/2016 Shelton, IV et al.
2016/0235467 A1 8/2016 Godara et al.
2016/0235494 A1 8/2016 Shelton, IV et al.
2016/0242782 A1 8/2016 Shelton, IV et al.
2016/0242783 A1 8/2016 Shelton, IV et al.
2016/0249910 A1 9/2016 Shelton, IV et al.
2016/0249922 A1 9/2016 Morgan et al.
2016/0256071 A1 9/2016 Shelton, IV et al.
2016/0256154 A1 9/2016 Shelton, IV et al.
2016/0256159 A1 9/2016 Pinjala et al.
2016/0256160 A1 9/2016 Shelton, IV et al.
2016/0256229 A1 9/2016 Morgan et al.
2016/0262745 A1 9/2016 Morgan et al.
2016/0262746 A1 9/2016 Shelton, IV et al.
2016/0262921 A1 9/2016 Balbierz et al.
2016/0270780 A1 9/2016 Hall et al.
2016/0278765 A1 9/2016 Shelton, IV et al.
2016/0278771 A1 9/2016 Shelton, IV et al.
2016/0287279 A1 10/2016 Bovay et al.
2016/0310143 A1 10/2016 Bettuchi
2016/0345976 A1 12/2016 Gonzalez et al.
2016/0346034 A1 12/2016 Arya et al.
2016/0354088 A1 12/2016 Cabrera et al.
2016/0367122 A1 12/2016 Ichimura et al.
2016/0374672 A1 12/2016 Bear et al.
2016/0374675 A1 12/2016 Shelton, IV et al.
2016/0374678 A1 12/2016 Becerra et al.
2017/0007236 A1 1/2017 Shelton, IV et al.
2017/0007237 A1 1/2017 Yates et al.
2017/0007243 A1 1/2017 Shelton, IV et al.
2017/0007244 A1 1/2017 Shelton, IV et al.
2017/0007245 A1 1/2017 Shelton, IV et al.
2017/0007247 A1 1/2017 Shelton, IV et al.
2017/0007248 A1 1/2017 Shelton, IV et al.
2017/0007249 A1 1/2017 Shelton, IV et al.
2017/0007250 A1 1/2017 Shelton, IV et al.
2017/0007347 A1 1/2017 Jaworek et al.
2017/0014125 A1 1/2017 Shelton, IV et al.
2017/0027572 A1 2/2017 Nalagatla et al.
2017/0027573 A1 2/2017 Nalagatla et al.
2017/0049444 A1 2/2017 Schellin et al.
2017/0049447 A1 2/2017 Barton et al.
2017/0049448 A1 2/2017 Widenhouse et al.
2017/0055986 A1 3/2017 Harris et al.
2017/0055999 A1 3/2017 Baxter, III et al.
2017/0056000 A1 3/2017 Nalagatla et al.
2017/0056002 A1 3/2017 Nalagatla et al.
2017/0056005 A1 3/2017 Shelton, IV et al.
2017/0079642 A1 3/2017 Overmyer et al.
2017/0086827 A1 3/2017 Vendely et al.
2017/0086829 A1 3/2017 Vendely et al.
2017/0086830 A1 3/2017 Yates et al.
2017/0086831 A1 3/2017 Shelton, IV et al.
2017/0086832 A1 3/2017 Harris et al.
2017/0086836 A1 3/2017 Harris et al.
2017/0086838 A1 3/2017 Harris et al.
2017/0086842 A1 3/2017 Shelton, IV et al.
2017/0086843 A1 3/2017 Vendely et al.
2017/0086844 A1 3/2017 Vendely et al.
2017/0105733 A1 4/2017 Scheib et al.
2017/0119388 A1 5/2017 Kostrzewski
2017/0119390 A1 5/2017 Schellin et al.
2017/0119397 A1 5/2017 Harris et al.
2017/0143335 A1 5/2017 Gupta et al.
2017/0150965 A1 6/2017 Williams
2017/0172382 A1 6/2017 Nir et al.
2017/0172550 A1 6/2017 Mukherjee et al.
2017/0172662 A1 6/2017 Panescu et al.
2017/0172672 A1 6/2017 Bailey et al.
2017/0182211 A1 6/2017 Raxworthy et al.
2017/0196558 A1 7/2017 Morgan et al.
2017/0196561 A1 7/2017 Shelton, IV et al.
2017/0196562 A1 7/2017 Shelton, IV et al.
2017/0196637 A1 7/2017 Shelton, IV et al.
2017/0196648 A1 7/2017 Ward et al.
2017/0196649 A1 7/2017 Yates et al.
2017/0202571 A1 7/2017 Shelton, IV et al.
2017/0202596 A1 7/2017 Shelton, IV et al.
2017/0202770 A1 7/2017 Friedrich et al.
2017/0209145 A1 7/2017 Swayze et al.
2017/0209146 A1 7/2017 Yates et al.
2017/0209226 A1 7/2017 Overmyer et al.
2017/0215881 A1 8/2017 Shelton, IV et al.
2017/0215943 A1 8/2017 Allen, IV
2017/0224331 A1 8/2017 Worthington et al.
2017/0224332 A1 8/2017 Hunter et al.
2017/0224334 A1 8/2017 Worthington et al.
2017/0224335 A1 8/2017 Weaner et al.
2017/0224339 A1 8/2017 Huang et al.
2017/0231627 A1 8/2017 Shelton, IV et al.
2017/0231628 A1 8/2017 Shelton, IV et al.
2017/0238928 A1 8/2017 Morgan et al.
2017/0238929 A1 8/2017 Yates et al.
2017/0245854 A1 8/2017 Zemlok et al.
2017/0245952 A1 8/2017 Shelton, IV et al.
2017/0249431 A1 8/2017 Shelton, IV et al.
2017/0258469 A1 9/2017 Shelton, IV et al.
2017/0265774 A1 9/2017 Johnson et al.
2017/0265856 A1 9/2017 Shelton, IV et al.
2017/0281155 A1 10/2017 Shelton, IV et al.
2017/0281164 A1 10/2017 Harris et al.
2017/0281166 A1 10/2017 Morgan et al.
2017/0281167 A1 10/2017 Shelton, IV et al.
2017/0281169 A1 10/2017 Harris et al.
2017/0281171 A1 10/2017 Shelton, IV et al.
2017/0281173 A1 10/2017 Shelton, IV et al.
2017/0281174 A1 10/2017 Harris et al.
2017/0281183 A1 10/2017 Miller et al.
2017/0281184 A1 10/2017 Shelton, IV et al.
2017/0281185 A1 10/2017 Miller et al.
2017/0281186 A1 10/2017 Shelton, IV et al.
2017/0281187 A1 10/2017 Shelton, IV et al.
2017/0281189 A1 10/2017 Nalagatla et al.
2017/0290584 A1 10/2017 Jasemian et al.
2017/0290585 A1 10/2017 Shelton, IV et al.
2017/0296169 A1 10/2017 Yates et al.
2017/0296170 A1 10/2017 Shelton, IV et al.
2017/0296173 A1 10/2017 Shelton, IV et al.
2017/0296177 A1 10/2017 Harris et al.
2017/0296179 A1 10/2017 Shelton, IV et al.
2017/0296185 A1 10/2017 Swensgard et al.
2017/0296213 A1 10/2017 Swensgard et al.
2017/0311944 A1 11/2017 Morgan et al.
2017/0311949 A1 11/2017 Shelton, IV
2017/0312041 A1 11/2017 Giordano et al.
2017/0312042 A1 11/2017 Giordano et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2017/0319201 A1 11/2017 Morgan et al.
2017/0319207 A1 11/2017 Shelton, IV et al.
2017/0319209 A1 11/2017 Morgan et al.
2017/0325813 A1 11/2017 Aranyi et al.
2017/0333034 A1 11/2017 Morgan et al.
2017/0333035 A1 11/2017 Morgan et al.
2017/0333070 A1 11/2017 Laurent et al.
2017/0348010 A1 12/2017 Chiang
2017/0348043 A1 12/2017 Wang et al.
2017/0354413 A1 12/2017 Chen et al.
2017/0354415 A1 12/2017 Casasanta, Jr. et al.
2017/0358052 A1 12/2017 Yuan
2017/0360439 A1 12/2017 Chen et al.
2017/0360441 A1 12/2017 Sgroi
2017/0360442 A1 12/2017 Shelton, IV et al.
2017/0364183 A1 12/2017 Xiao
2017/0367695 A1 12/2017 Shelton, IV et al.
2017/0367696 A1 12/2017 Shelton, IV et al.
2017/0367697 A1 12/2017 Shelton, IV et al.
2017/0367698 A1 12/2017 Shelton, IV et al.
2017/0367699 A1 12/2017 Shelton, IV et al.
2017/0367700 A1 12/2017 Leimbach et al.
2017/0367991 A1 12/2017 Widenhouse et al.
2018/0000483 A1 1/2018 Leimbach et al.
2018/0000545 A1 1/2018 Giordano et al.
2018/0008270 A1 1/2018 Moore et al.
2018/0008271 A1 1/2018 Moore et al.
2018/0008356 A1 1/2018 Giordano et al.
2018/0008357 A1 1/2018 Giordano et al.
2018/0028184 A1 2/2018 Shelton, IV et al.
2018/0028185 A1 2/2018 Shelton, IV et al.
2018/0042611 A1 2/2018 Swayze et al.
2018/0049819 A1 2/2018 Harris et al.
2018/0049824 A1 2/2018 Harris et al.
2018/0049883 A1 2/2018 Moskowitz et al.
2018/0055513 A1 3/2018 Shelton, IV et al.
2018/0055524 A1 3/2018 Shelton, IV et al.
2018/0055525 A1 3/2018 Shelton, IV et al.
2018/0055526 A1 3/2018 Shelton, IV et al.
2018/0064437 A1 3/2018 Yates et al.
2018/0064440 A1 3/2018 Shelton, IV et al.
2018/0064441 A1 3/2018 Shelton, IV et al.
2018/0064442 A1 3/2018 Shelton, IV et al.
2018/0064443 A1 3/2018 Shelton, IV et al.
2018/0070939 A1 3/2018 Giordano et al.
2018/0070942 A1 3/2018 Shelton, IV et al.
2018/0078248 A1 3/2018 Swayze et al.
2018/0078268 A1 3/2018 Messerly et al.
2018/0085116 A1 3/2018 Yates et al.
2018/0085117 A1 3/2018 Shelton, IV et al.
2018/0103953 A1 4/2018 Shelton, IV et al.
2018/0103955 A1 4/2018 Shelton, IV et al.
2018/0110516 A1 4/2018 Baxter, III et al.
2018/0110518 A1 4/2018 Overmyer et al.
2018/0110519 A1 4/2018 Lytle, IV et al.
2018/0110520 A1 4/2018 Shelton, IV et al.
2018/0110521 A1 4/2018 Shelton, IV et al.
2018/0110522 A1 4/2018 Shelton, IV et al.
2018/0110523 A1 4/2018 Shelton, IV
2018/0110574 A1 4/2018 Shelton, IV et al.
2018/0110575 A1 4/2018 Shelton, IV et al.
2018/0114591 A1 4/2018 Pribanic et al.
2018/0116658 A1 5/2018 Aronhalt, IV et al.
2018/0116662 A1 5/2018 Shelton, IV et al.
2018/0116665 A1 5/2018 Hall et al.
2018/0125481 A1 5/2018 Yates et al.
2018/0125484 A1 5/2018 Kostrzewski
2018/0125487 A1 5/2018 Beardsley
2018/0125488 A1 5/2018 Morgan et al.
2018/0125489 A1 5/2018 Leimbach et al.
2018/0125590 A1 5/2018 Giordano et al.
2018/0125594 A1 5/2018 Beardsley
2018/0126504 A1 5/2018 Shelton, IV et al.
2018/0132845 A1 5/2018 Schmid et al.
2018/0132849 A1 5/2018 Miller et al.
2018/0132850 A1 5/2018 Leimbach et al.
2018/0132851 A1 5/2018 Hall et al.
2018/0132926 A1 5/2018 Asher et al.
2018/0132952 A1 5/2018 Spivey et al.
2018/0133856 A1 5/2018 Shelton, IV et al.
2018/0140299 A1 5/2018 Weaner et al.
2018/0140368 A1 5/2018 Shelton, IV et al.
2018/0146960 A1 5/2018 Shelton, IV et al.
2018/0150153 A1 5/2018 Yoon et al.
2018/0153542 A1 6/2018 Shelton, IV et al.
2018/0161034 A1 6/2018 Scheib et al.
2018/0168575 A1 6/2018 Simms et al.
2018/0168576 A1 6/2018 Hunter et al.
2018/0168577 A1 6/2018 Aronhalt et al.
2018/0168578 A1 6/2018 Aronhalt et al.
2018/0168579 A1 6/2018 Aronhalt et al.
2018/0168580 A1 6/2018 Hunter et al.
2018/0168581 A1 6/2018 Hunter et al.
2018/0168582 A1 6/2018 Swayze et al.
2018/0168583 A1 6/2018 Hunter et al.
2018/0168584 A1 6/2018 Harris et al.
2018/0168585 A1 6/2018 Shelton, IV et al.
2018/0168586 A1 6/2018 Shelton, IV et al.
2018/0168589 A1 6/2018 Swayze et al.
2018/0168590 A1 6/2018 Overmyer et al.
2018/0168591 A1 6/2018 Swayze et al.
2018/0168592 A1 6/2018 Overmyer et al.
2018/0168593 A1 6/2018 Overmyer et al.
2018/0168594 A1 6/2018 Shelton, IV et al.
2018/0168595 A1 6/2018 Overmyer et al.
2018/0168596 A1 6/2018 Beckman et al.
2018/0168597 A1 6/2018 Fanelli et al.
2018/0168598 A1 6/2018 Shelton, IV et al.
2018/0168599 A1 6/2018 Bakos et al.
2018/0168600 A1 6/2018 Shelton, IV et al.
2018/0168601 A1 6/2018 Bakos et al.
2018/0168602 A1 6/2018 Bakos et al.
2018/0168603 A1 6/2018 Morgan et al.
2018/0168604 A1 6/2018 Shelton, IV et al.
2018/0168605 A1 6/2018 Baber et al.
2018/0168606 A1 6/2018 Shelton, IV et al.
2018/0168607 A1 6/2018 Shelton, IV et al.
2018/0168608 A1 6/2018 Shelton, IV et al.
2018/0168609 A1 6/2018 Fanelli et al.
2018/0168610 A1 6/2018 Shelton, IV et al.
2018/0168611 A1 6/2018 Shelton, IV et al.
2018/0168613 A1 6/2018 Shelton, IV et al.
2018/0168614 A1 6/2018 Shelton, IV et al.
2018/0168615 A1 6/2018 Shelton, IV et al.
2018/0168616 A1 6/2018 Shelton, IV et al.
2018/0168617 A1 6/2018 Shelton, IV et al.
2018/0168618 A1 6/2018 Scott et al.
2018/0168619 A1 6/2018 Scott et al.
2018/0168620 A1 6/2018 Huang et al.
2018/0168621 A1 6/2018 Shelton, IV et al.
2018/0168623 A1 6/2018 Simms et al.
2018/0168624 A1 6/2018 Shelton, IV et al.
2018/0168625 A1 6/2018 Posada et al.
2018/0168626 A1 6/2018 Shelton, IV et al.
2018/0168627 A1 6/2018 Weaner et al.
2018/0168628 A1 6/2018 Hunter et al.
2018/0168629 A1 6/2018 Shelton, IV et al.
2018/0168630 A1 6/2018 Shelton, IV et al.
2018/0168631 A1 6/2018 Harris et al.
2018/0168632 A1 6/2018 Harris et al.
2018/0168633 A1 6/2018 Shelton, IV et al.
2018/0168634 A1 6/2018 Harris et al.
2018/0168635 A1 6/2018 Shelton, IV et al.
2018/0168636 A1 6/2018 Shelton, IV et al.
2018/0168637 A1 6/2018 Harris et al.
2018/0168638 A1 6/2018 Harris et al.
2018/0168639 A1 6/2018 Shelton, IV et al.
2018/0168640 A1 6/2018 Shelton, IV et al.
2018/0168641 A1 6/2018 Harris et al.
2018/0168642 A1 6/2018 Shelton, IV et al.
2018/0168643 A1 6/2018 Shelton, IV et al.
2018/0168644 A1 6/2018 Shelton, IV et al.
2018/0168645 A1 6/2018 Shelton, IV et al.
2018/0168646 A1 6/2018 Shelton, IV et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0168647 A1 6/2018 Shelton, IV et al.
2018/0168648 A1 6/2018 Shelton, IV et al.
2018/0168649 A1 6/2018 Shelton, IV et al.
2018/0168650 A1 6/2018 Shelton, IV et al.
2018/0168651 A1 6/2018 Shelton, IV et al.
2018/0168715 A1 6/2018 Strobl
2018/0199940 A1 7/2018 Zergiebel et al.
2018/0206843 A1 7/2018 Yates et al.
2018/0206906 A1 7/2018 Moua et al.
2018/0214147 A1 8/2018 Merchant et al.
2018/0221046 A1 8/2018 Demmy et al.
2018/0221050 A1 8/2018 Kostrzewski et al.
2018/0228490 A1 8/2018 Richard et al.
2018/0242962 A1 8/2018 Walen et al.
2018/0250001 A1 9/2018 Aronhalt et al.
2018/0250020 A1 9/2018 Carusillo
2018/0250086 A1 9/2018 Grubbs
2018/0271520 A1 9/2018 Shelton, IV et al.
2018/0273597 A1 9/2018 Stimson
2018/0280020 A1 10/2018 Hess et al.
2018/0286274 A1 10/2018 Kamiguchi et al.
2018/0289369 A1 10/2018 Shelton, IV et al.
2018/0296211 A1 10/2018 Timm et al.
2018/0296215 A1 10/2018 Baxter, III et al.
2018/0296216 A1 10/2018 Shelton, IV et al.
2018/0296217 A1 10/2018 Moore et al.
2018/0303481 A1 10/2018 Shelton, IV et al.
2018/0303482 A1 10/2018 Shelton, IV et al.
2018/0310931 A1 11/2018 Hall et al.
2018/0311002 A1 11/2018 Giordano et al.
2018/0317907 A1 11/2018 Kostrzewski
2018/0317916 A1 11/2018 Wixey
2018/0317917 A1 11/2018 Huang et al.
2018/0317918 A1 11/2018 Shelton, IV
2018/0317919 A1 11/2018 Shelton, IV et al.
2018/0325528 A1 11/2018 Windolf et al.
2018/0333155 A1 11/2018 Hall et al.
2018/0333169 A1 11/2018 Leimbach et al.
2018/0344319 A1 12/2018 Shelton, IV et al.
2018/0353170 A1 12/2018 Overmyer et al.
2018/0353176 A1 12/2018 Shelton, IV et al.
2018/0353177 A1 12/2018 Shelton, IV et al.
2018/0353178 A1 12/2018 Shelton, IV et al.
2018/0353179 A1 12/2018 Shelton, IV et al.
2018/0360443 A1 12/2018 Shelton, IV et al.
2018/0360445 A1 12/2018 Shelton, IV et al.
2018/0360446 A1 12/2018 Shelton, IV et al.
2018/0360447 A1 12/2018 Shelton, IV et al.
2018/0360448 A1 12/2018 Harris et al.
2018/0360449 A1 12/2018 Shelton, IV et al.
2018/0360450 A1 12/2018 Shelton, IV et al.
2018/0360452 A1 12/2018 Shelton, IV et al.
2018/0360454 A1 12/2018 Shelton, IV et al.
2018/0360455 A1 12/2018 Shelton, IV et al.
2018/0360456 A1 12/2018 Shelton, IV et al.
2018/0360471 A1 12/2018 Parfett et al.
2018/0360472 A1 12/2018 Harris et al.
2018/0360473 A1 12/2018 Shelton, IV et al.
2018/0360549 A1 12/2018 Hares et al.
2018/0368822 A1 12/2018 Shelton, IV et al.
2018/0368833 A1 12/2018 Shelton, IV et al.
2018/0368837 A1 12/2018 Morgan et al.
2018/0368838 A1 12/2018 Shelton, IV et al.
2018/0368839 A1 12/2018 Shelton, IV et al.
2018/0368840 A1 12/2018 Shelton, IV et al.
2018/0368841 A1 12/2018 Shelton, IV et al.
2018/0368842 A1 12/2018 Shelton, IV et al.
2018/0368843 A1 12/2018 Shelton, IV et al.
2018/0368844 A1 12/2018 Bakos et al.
2018/0368845 A1 12/2018 Bakos et al.
2018/0368846 A1 12/2018 Shelton, IV et al.
2018/0368847 A1 12/2018 Shelton, IV et al.
2019/0000446 A1 1/2019 Shelton, IV et al.
2019/0000448 A1 1/2019 Shelton, IV et al.
2019/0000450 A1 1/2019 Shelton, IV et al.
2019/0000454 A1 1/2019 Swayze et al.
2019/0000456 A1 1/2019 Shelton, IV et al.
2019/0000457 A1 1/2019 Shelton, IV et al.
2019/0000458 A1 1/2019 Shelton, IV et al.
2019/0000459 A1 1/2019 Shelton, IV et al.
2019/0000460 A1 1/2019 Shelton, IV et al.
2019/0000461 A1 1/2019 Shelton, IV et al.
2019/0000462 A1 1/2019 Shelton, IV et al.
2019/0000463 A1 1/2019 Shelton, IV et al.
2019/0000464 A1 1/2019 Shelton, IV et al.
2019/0000465 A1 1/2019 Shelton, IV et al.
2019/0000466 A1 1/2019 Shelton, IV et al.
2019/0000467 A1 1/2019 Shelton, IV et al.
2019/0000468 A1 1/2019 Adams et al.
2019/0000469 A1 1/2019 Shelton, IV et al.
2019/0000470 A1 1/2019 Yates et al.
2019/0000471 A1 1/2019 Shelton, IV et al.
2019/0000472 A1 1/2019 Shelton, IV et al.
2019/0000473 A1 1/2019 Shelton, IV et al.
2019/0000474 A1 1/2019 Shelton, IV et al.
2019/0000475 A1 1/2019 Shelton, IV et al.
2019/0000476 A1 1/2019 Shelton, IV et al.
2019/0000477 A1 1/2019 Shelton, IV et al.
2019/0000478 A1 1/2019 Messerly et al.
2019/0000479 A1 1/2019 Harris et al.
2019/0000525 A1 1/2019 Messerly et al.
2019/0000528 A1 1/2019 Yates et al.
2019/0000530 A1 1/2019 Yates et al.
2019/0000531 A1 1/2019 Messerly et al.
2019/0000534 A1 1/2019 Messerly et al.
2019/0000538 A1 1/2019 Widenhouse et al.
2019/0000555 A1 1/2019 Schings et al.
2019/0000565 A1 1/2019 Shelton, IV et al.
2019/0003292 A1 1/2019 Balan et al.
2019/0008509 A1 1/2019 Shelton, IV et al.
2019/0008511 A1 1/2019 Kerr et al.
2019/0015096 A1 1/2019 Shelton, IV et al.
2019/0015102 A1 1/2019 Baber et al.
2019/0015165 A1 1/2019 Giordano et al.
2019/0029675 A1 1/2019 Yates et al.
2019/0029676 A1 1/2019 Yates et al.
2019/0029677 A1 1/2019 Yates et al.
2019/0029678 A1 1/2019 Shelton, IV et al.
2019/0029681 A1 1/2019 Swayze et al.
2019/0029682 A1 1/2019 Huitema et al.
2019/0029701 A1 1/2019 Shelton, IV et al.
2019/0033955 A1 1/2019 Leimbach et al.
2019/0038279 A1 2/2019 Shelton, IV et al.
2019/0038281 A1 2/2019 Shelton, IV et al.
2019/0038282 A1 2/2019 Shelton, IV et al.
2019/0038283 A1 2/2019 Shelton, IV et al.
2019/0038292 A1 2/2019 Zhang
2019/0038371 A1 2/2019 Wixey et al.
2019/0046181 A1 2/2019 McCuen
2019/0046187 A1 2/2019 Yates et al.
2019/0059886 A1 2/2019 Shelton, IV et al.
2019/0090870 A1 3/2019 Shelton, IV et al.
2019/0090871 A1 3/2019 Shelton, IV et al.
2019/0091183 A1 3/2019 Tomat et al.
2019/0099177 A1 4/2019 Yates et al.
2019/0099178 A1 4/2019 Leimbach et al.
2019/0099179 A1 4/2019 Leimbach et al.
2019/0099180 A1 4/2019 Leimbach et al.
2019/0099181 A1 4/2019 Shelton, IV et al.
2019/0099182 A1 4/2019 Bakos et al.
2019/0099183 A1 4/2019 Leimbach et al.
2019/0099184 A1 4/2019 Setser et al.
2019/0099224 A1 4/2019 Leimbach et al.
2019/0099229 A1 4/2019 Spivey et al.
2019/0102930 A1 4/2019 Leimbach et al.
2019/0105035 A1 4/2019 Shelton, IV et al.
2019/0105036 A1 4/2019 Morgan et al.
2019/0105037 A1 4/2019 Morgan et al.
2019/0105038 A1 4/2019 Schmid et al.
2019/0105039 A1 4/2019 Morgan et al.
2019/0105043 A1 4/2019 Jaworek et al.
2019/0105044 A1 4/2019 Shelton, IV et al.
2019/0105049 A1 4/2019 Moore et al.
2019/0110791 A1 4/2019 Shelton, IV et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2019/0110792 A1 4/2019 Shelton, IV et al.
2019/0110793 A1 4/2019 Parihar et al.
2019/0117216 A1 4/2019 Overmyer et al.
2019/0117217 A1 4/2019 Overmyer et al.
2019/0117222 A1 4/2019 Shelton, IV et al.
2019/0117224 A1 4/2019 Setser et al.
2019/0117225 A1 4/2019 Moore et al.
2019/0125343 A1 5/2019 Wise et al.
2019/0125344 A1 5/2019 DiNardo et al.
2019/0125345 A1 5/2019 Baber et al.
2019/0125365 A1 5/2019 Parfett et al.
2019/0125380 A1 5/2019 Hunter et al.
2019/0125475 A1 5/2019 Wise et al.
2019/0133585 A1 5/2019 Smith et al.
2019/0142421 A1 5/2019 Shelton, IV
2019/0183490 A1 6/2019 Shelton, IV et al.
2019/0183491 A1 6/2019 Shelton, IV et al.
2019/0183492 A1 6/2019 Shelton, IV et al.
2019/0183493 A1 6/2019 Shelton, IV et al.
2019/0183494 A1 6/2019 Shelton, IV et al.
2019/0183495 A1 6/2019 Shelton, IV et al.
2019/0183496 A1 6/2019 Shelton, IV et al.
2019/0183497 A1 6/2019 Shelton, IV et al.
2019/0183498 A1 6/2019 Shelton, IV et al.
2019/0183499 A1 6/2019 Shelton, IV et al.
2019/0183500 A1 6/2019 Shelton, IV et al.
2019/0183501 A1 6/2019 Shelton, IV et al.
2019/0183502 A1 6/2019 Shelton, IV et al.
2019/0183503 A1 6/2019 Shelton, IV et al.
2019/0183504 A1 6/2019 Shelton, IV et al.
2019/0183505 A1 6/2019 Vendely et al.
2019/0183592 A1 6/2019 Shelton, IV et al.
2019/0183594 A1 6/2019 Shelton, IV et al.
2019/0183597 A1 6/2019 Shelton, IV et al.
2019/0192137 A1 6/2019 Shelton, IV et al.
2019/0192138 A1 6/2019 Shelton, IV et al.
2019/0192141 A1 6/2019 Shelton, IV et al.
2019/0192144 A1 6/2019 Parfett et al.
2019/0192145 A1 6/2019 Shelton, IV et al.
2019/0192146 A1 6/2019 Widenhouse et al.
2019/0192147 A1 6/2019 Shelton, IV et al.
2019/0192148 A1 6/2019 Shelton, IV et al.
2019/0192149 A1 6/2019 Shelton, IV et al.
2019/0192150 A1 6/2019 Widenhouse et al.
2019/0192151 A1 6/2019 Shelton, IV et al.
2019/0192152 A1 6/2019 Morgan et al.
2019/0192153 A1 6/2019 Shelton, IV et al.
2019/0192154 A1 6/2019 Shelton, IV et al.
2019/0192155 A1 6/2019 Shelton, IV et al.
2019/0192156 A1 6/2019 Simms et al.
2019/0192157 A1 6/2019 Scott et al.
2019/0192158 A1 6/2019 Scott et al.
2019/0192159 A1 6/2019 Simms et al.
2019/0192227 A1 6/2019 Shelton, IV et al.
2019/0192235 A1 6/2019 Harris et al.
2019/0192236 A1 6/2019 Shelton, IV et al.
2019/0200895 A1 7/2019 Shelton, IV et al.
2019/0200991 A1 7/2019 Moore et al.
2019/0200992 A1 7/2019 Moore et al.
2019/0200993 A1 7/2019 Moore et al.
2019/0200994 A1 7/2019 Moore et al.
2019/0209164 A1 7/2019 Timm et al.
2019/0209165 A1 7/2019 Timm et al.
2019/0209171 A1 7/2019 Shelton, IV et al.
2019/0209172 A1 7/2019 Shelton, IV et al.
2019/0209247 A1 7/2019 Giordano et al.
2019/0209248 A1 7/2019 Giordano et al.
2019/0209249 A1 7/2019 Giordano et al.
2019/0209250 A1 7/2019 Giordano et al.
2019/0216558 A1 7/2019 Giordano et al.
2019/0223865 A1 7/2019 Shelton, IV et al.
2019/0223871 A1 7/2019 Moore et al.
2019/0261991 A1 8/2019 Beckman et al.
2019/0267403 A1 8/2019 Li et al.
2019/0269400 A1 9/2019 Mandakolathur Vasudevan et al.
2019/0269402 A1 9/2019 Murray et al.
2019/0269403 A1 9/2019 Baxter, III et al.
2019/0269407 A1 9/2019 Swensgard et al.
2019/0290263 A1 9/2019 Morgan et al.
2019/0290264 A1 9/2019 Morgan et al.
2019/0290265 A1 9/2019 Shelton, IV et al.
2019/0290274 A1 9/2019 Shelton, IV
2019/0321040 A1 10/2019 Shelton, IV
2019/0321041 A1 10/2019 Shelton, IV

FOREIGN PATENT DOCUMENTS

CA 1015829 A 8/1977
CA 1125615 A 6/1982
CA 2520413 A1 3/2007
CA 2725181 A1 11/2007
CA 2851239 A1 11/2007
CA 2664874 A1 11/2009
CA 2813230 A1 4/2012
CA 2940510 A1 8/2015
CA 2698728 C 8/2016
CN 1163558 A 10/1997
CN 2488482 Y 5/2002
CN 1634601 A 7/2005
CN 2716900 Y 8/2005
CN 2738962 Y 11/2005
CN 1777406 A 5/2006
CN 2796654 Y 7/2006
CN 2868212 Y 2/2007
CN 200942099 Y 9/2007
CN 200984209 Y 12/2007
CN 200991269 Y 12/2007
CN 201001747 Y 1/2008
CN 101143105 A 3/2008
CN 201029899 Y 3/2008
CN 101378791 A 3/2009
CN 101522120 A 9/2009
CN 101669833 A 3/2010
CN 101721236 A 6/2010
CN 101828940 A 9/2010
CN 101873834 A 10/2010
CN 201719298 U 1/2011
CN 102038532 A 5/2011
CN 201879759 U 6/2011
CN 201949071 U 8/2011
CN 102217963 A 10/2011
CN 101779977 B 12/2011
CN 101912284 B 7/2012
CN 102125450 B 7/2012
CN 202313537 U 7/2012
CN 202397539 U 8/2012
CN 202426586 U 9/2012
CN 202489990 U 10/2012
CN 102228387 B 11/2012
CN 102835977 A 12/2012
CN 202568350 U 12/2012
CN 103690212 A 4/2014
CN 203564285 U 4/2014
CN 203564287 U 4/2014
CN 203597997 U 5/2014
CN 103829981 A 6/2014
CN 103829983 A 6/2014
CN 103908313 A 7/2014
CN 203693685 U 7/2014
CN 203736251 U 7/2014
CN 103981635 A 8/2014
CN 203815517 U 9/2014
CN 102783741 B 10/2014
CN 102973300 B 10/2014
CN 104337556 A 2/2015
CN 204158440 U 2/2015
CN 204158441 U 2/2015
CN 102469995 B 3/2015
CN 204636451 U 9/2015
CN 103860225 B 3/2016
CN 103750872 B 5/2016
DE 273689 C 5/1914
DE 1775926 A 1/1972
DE 3036217 A1 4/1982

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

DE	3210466	A1	9/1983
DE	3709067	A1	9/1988
DE	19534043	A1	3/1997
DE	19851291	A1	1/2000
DE	19924311	A1	11/2000
DE	20016423	U1	2/2001
DE	20112837	U1	10/2001
DE	20121753	U1	4/2003
DE	202004012389	U1	9/2004
DE	10314072	A1	10/2004
DE	102004014011	A1	10/2005
DE	102004063606	A1	7/2006
DE	202007003114	U1	6/2007
DE	102010013150	A1	9/2011
EP	0000756	A1	2/1979
EP	0122046	A1	10/1984
EP	0129442	B1	11/1987
EP	0255631	A1	2/1988
EP	0169044	B1	6/1991
EP	0541950	A1	5/1993
EP	0548998	A1	6/1993
EP	0594148	A1	4/1994
EP	0646357	A1	4/1995
EP	0505036	B1	5/1995
EP	0669104	A1	8/1995
EP	0705571	A1	4/1996
EP	0528478	B1	5/1996
EP	0770355	A1	5/1997
EP	0625335	B1	11/1997
EP	0879742	A1	11/1998
EP	0650701	B1	3/1999
EP	0923907	A1	6/1999
EP	0484677	B2	7/2000
EP	1034747	A1	9/2000
EP	1034748	A1	9/2000
EP	0726632	B1	10/2000
EP	1053719	A1	11/2000
EP	1055399	A1	11/2000
EP	1055400	A1	11/2000
EP	1080694	A1	3/2001
EP	1090592	A1	4/2001
EP	1095627	A1	5/2001
EP	0806914	B1	9/2001
EP	1234587	A1	8/2002
EP	1284120	A1	2/2003
EP	0717967	B1	5/2003
EP	0869742	B1	5/2003
EP	1374788	A1	1/2004
EP	1407719	A2	4/2004
EP	0996378	B1	6/2004
EP	1157666	B1	9/2005
EP	0880338	B1	10/2005
EP	1158917	B1	11/2005
EP	1344498	B1	11/2005
EP	1330989	B1	12/2005
EP	1632191	A2	3/2006
EP	1082944	B1	5/2006
EP	1253866	B1	7/2006
EP	1723914	A1	11/2006
EP	1285633	B1	12/2006
EP	1011494	B1	1/2007
EP	1767163	A1	3/2007
EP	1837041	A1	9/2007
EP	0922435	B1	10/2007
EP	1599146	B1	10/2007
EP	1330201	B1	6/2008
EP	2039302	A2	3/2009
EP	1719461	B1	6/2009
EP	2116196	A2	11/2009
EP	1769754	B1	6/2010
EP	1627605	B1	12/2010
EP	2316345	A1	5/2011
EP	1962711	B1	2/2012
EP	2486862	A2	8/2012
EP	2486868	A2	8/2012
EP	2517638	A1	10/2012
EP	2606812	A1	6/2013
EP	2649948	A1	10/2013
EP	2649949	A1	10/2013
EP	2668910	A2	12/2013
EP	2687164	A2	1/2014
EP	2713902	A1	4/2014
EP	2743042	A2	6/2014
EP	2764827	A2	8/2014
EP	2777524	A2	9/2014
EP	2842500	A1	3/2015
EP	2853220	A1	4/2015
EP	2298220	B1	6/2016
EP	2510891	B1	6/2016
EP	3031404	A1	6/2016
EP	3047806	A1	7/2016
EP	3078334	A1	10/2016
EP	2364651	B1	11/2016
EP	2747235	B1	11/2016
EP	2789299	B1	5/2017
EP	3225190	A2	10/2017
EP	3363378	A1	8/2018
FR	459743	A	11/1913
FR	999646	A	2/1952
FR	1112936	A	3/1956
FR	2598905	A1	11/1987
FR	2689749	B1	7/1994
FR	2765794	A1	1/1999
FR	2815842	A1	5/2002
GB	939929	A	10/1963
GB	1210522	A	10/1970
GB	1217159	A	12/1970
GB	1339394	A	12/1973
GB	2024012	A	1/1980
GB	2109241	A	6/1983
GB	2090534	B	6/1984
GB	2272159	A	5/1994
GB	2336214	A	10/1999
GB	2509523	A	7/2014
GR	930100110	A	11/1993
JP	S4711908	Y1	5/1972
JP	S5033988	U	4/1975
JP	S5367286	A	6/1978
JP	S56112235	A	9/1981
JP	S60113007	A	6/1985
JP	S62170011	U	10/1987
JP	S63270040	A	11/1988
JP	H0129503	B2	6/1989
JP	H0378514	U	8/1991
JP	H0385009	U	8/1991
JP	H04215747	A	8/1992
JP	H04131860	U	12/1992
JP	H0584252	A	4/1993
JP	H05123325	A	5/1993
JP	H05226945	A	9/1993
JP	H0630945	A	2/1994
JP	H06237937	A	8/1994
JP	H06327684	A	11/1994
JP	H079622	U	2/1995
JP	H07124166	A	5/1995
JP	H07163573	A	6/1995
JP	H07255735	A	10/1995
JP	H07285089	A	10/1995
JP	H0833642	A	2/1996
JP	H08164141	A	6/1996
JP	H08182684	A	7/1996
JP	H08507708	A	8/1996
JP	H08229050	A	9/1996
JP	H08289895	A	11/1996
JP	H09-323068	A	12/1997
JP	H10118090	A	5/1998
JP	H10-200699	A	7/1998
JP	H10296660	A	11/1998
JP	2000014632	A	1/2000
JP	2000033071	A	2/2000
JP	2000112002	A	4/2000
JP	2000166932	A	6/2000
JP	2000171730	A	6/2000
JP	2000271141	A	10/2000

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

JP	2000287987	A	10/2000
JP	2000325303	A	11/2000
JP	2001087272	A	4/2001
JP	2001514541	A	9/2001
JP	2001276091	A	10/2001
JP	2002051974	A	2/2002
JP	2002054903	A	2/2002
JP	2002085415	A	3/2002
JP	2002143078	A	5/2002
JP	2002153481	A	5/2002
JP	2002528161	A	9/2002
JP	2002314298	A	10/2002
JP	2003135473	A	5/2003
JP	2003521301	A	7/2003
JP	3442423	B2	9/2003
JP	2003300416	A	10/2003
JP	2004147701	A	5/2004
JP	2004162035	A	6/2004
JP	2004229976	A	8/2004
JP	2005013573	A	1/2005
JP	2005080702	A	3/2005
JP	2005131163	A	5/2005
JP	2005131164	A	5/2005
JP	2005131173	A	5/2005
JP	2005131211	A	5/2005
JP	2005131212	A	5/2005
JP	2005137423	A	6/2005
JP	2005187954	A	7/2005
JP	2005211455	A	8/2005
JP	2005328882	A	12/2005
JP	2005335432	A	12/2005
JP	2005342267	A	12/2005
JP	3791856	B2	6/2006
JP	2006187649	A	7/2006
JP	2006218228	A	8/2006
JP	2006281405	A	10/2006
JP	2006346445	A	12/2006
JP	2008220032	A	9/2008
JP	2009507526	A	2/2009
JP	200990113	A	4/2009
JP	2009189838	A	8/2009
JP	2009189846	A	8/2009
JP	2009207260	A	9/2009
JP	2009226028	A	10/2009
JP	2009538684	A	11/2009
JP	2009539420	A	11/2009
JP	2010069307	A	4/2010
JP	2010069310	A	4/2010
JP	2010098844	A	4/2010
JP	2010214128	A	9/2010
JP	2011072574	A	4/2011
JP	4722849	B2	7/2011
JP	2011524199	A	9/2011
JP	2012143283	A	8/2012
JP	2012145767	A	8/2012
JP	5154710	B1	2/2013
JP	2014121599	A	7/2014
JP	2016512057	A	4/2016
KR	20100110134	A	10/2010
KR	20110003229	A	1/2011
RU	1814161	A1	5/1993
RU	1814161	C	5/1993
RU	2008830	C1	3/1994
RU	2052979	C1	1/1996
RU	2066128	C1	9/1996
RU	2069981	C1	12/1996
RU	2098025	C1	12/1997
RU	2104671	C1	2/1998
RU	2110965	C1	5/1998
RU	2141279	C1	11/1999
RU	2144791	C1	1/2000
RU	2161450	C1	1/2001
RU	2181566	C2	4/2002
RU	2187249	C2	8/2002
RU	32984	U1	10/2003
RU	2225170	C2	3/2004
RU	42750	U1	12/2004
RU	61114	U1	2/2007
RU	61122	U1	2/2007
RU	2430692	C2	10/2011
SU	189517	A	1/1967
SU	297156	A	5/1971
SU	328636	A	9/1972
SU	511939	A1	4/1976
SU	674747	A1	7/1979
SU	728848	A1	4/1980
SU	1009439	A	4/1983
SU	1271497	A1	11/1986
SU	1333319	A2	8/1987
SU	1377052	A1	2/1988
SU	1377053	A1	2/1988
SU	1443874	A1	12/1988
SU	1509051	A1	9/1989
SU	1561964	A1	5/1990
SU	1708312	A1	1/1992
SU	1722476	A1	3/1992
SU	1752361	A1	8/1992
WO	WO-9315648	A1	8/1993
WO	WO-9420030	A1	9/1994
WO	WO-9517855	A1	7/1995
WO	WO-9520360	A1	8/1995
WO	WO-9623448	A1	8/1996
WO	WO-9635464	A1	11/1996
WO	WO-9639086	A1	12/1996
WO	WO-9639088	A1	12/1996
WO	WO-9724073	A1	7/1997
WO	WO-9734533	A1	9/1997
WO	WO-9903407	A1	1/1999
WO	WO-9903409	A1	1/1999
WO	WO-9948430	A1	9/1999
WO	WO-0024322	A1	5/2000
WO	WO-0024330	A1	5/2000
WO	WO-0053112	A2	9/2000
WO	WO-0057796	A1	10/2000
WO	WO-0105702	A1	1/2001
WO	WO-0154594	A1	8/2001
WO	WO-0158371	A1	8/2001
WO	WO-0162164	A2	8/2001
WO	WO-0162169	A2	8/2001
WO	WO-0191646	A1	12/2001
WO	WO-0219932	A1	3/2002
WO	WO-0226143	A1	4/2002
WO	WO-0236028	A1	5/2002
WO	WO-02065933	A2	8/2002
WO	WO-03055402	A1	7/2003
WO	WO-03094747	A1	11/2003
WO	WO-03079909	A3	3/2004
WO	WO-2004019803	A1	3/2004
WO	WO-2004032783	A1	4/2004
WO	WO-2004047626	A1	6/2004
WO	WO-2004047653	A2	6/2004
WO	WO-2004056277	A1	7/2004
WO	WO-2004078050	A2	9/2004
WO	WO-2004078051	A2	9/2004
WO	WO-2004096015	A2	11/2004
WO	WO-2006044581	A2	4/2006
WO	WO-2006051252	A1	5/2006
WO	WO-2006059067	A1	6/2006
WO	WO-2006073581	A2	7/2006
WO	WO-2006085389	A1	8/2006
WO	WO-2007015971	A2	2/2007
WO	WO-2007074430	A1	7/2007
WO	WO-2007129121	A1	11/2007
WO	WO-2007137304	A2	11/2007
WO	WO-2007142625	A2	12/2007
WO	WO-2008021969	A2	2/2008
WO	WO-2008061566	A1	5/2008
WO	WO-2008089404	A2	7/2008
WO	WO-2009005969	A2	1/2009
WO	WO-2009067649	A2	5/2009
WO	WO-2009091497	A2	7/2009
WO	WO-2010126129	A1	11/2010
WO	WO-2010134913	A1	11/2010
WO	WO-2011008672	A2	1/2011

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	WO-2011044343	A2	4/2011
WO	WO-2012006306	A2	1/2012
WO	WO-2012013577	A1	2/2012
WO	WO-2012044606	A2	4/2012
WO	WO-2012061725	A1	5/2012
WO	WO-2012072133	A1	6/2012
WO	WO-2012166503	A1	12/2012
WO	WO-2013087092	A1	6/2013
WO	WO-2013151888	A1	10/2013
WO	WO-2014004209	A2	1/2014
WO	WO-2014113438	A1	7/2014
WO	WO-2015032797	A1	3/2015
WO	WO-2015138760	A1	9/2015
WO	WO-2015187107	A1	12/2015

OTHER PUBLICATIONS

"Foot and Ankle: Core Knowledge in Orthopaedics"; by DiGiovanni MD, Elsevier; (p. 27, left column, heading "Materials for Soft Orthoses", 7th bullet point); (Year: 2007).

"Indian Standard: Automotive Vehicles—Brakes and Braking Systems (IS 11852-1:2001)", Mar. 1, 2001.

"Pushing Pixels (GIF)", published on dribble.com, 2013.

"Sodium stearate C18H35NaO2", Chemspider Search and Share Chemistry, Royal Society of Chemistry, pp. 1-3, 2015, http://www.chemspider.com/Chemical-Structure.12639.html, accessed May 23, 2016.

"Tutorial overview of inductively coupled RFID Systems," UPM, May 2003, pp. 1-7, UPM Rafsec,<http://cdn.mobiusconsulting.com/papers/rfidsystems.pdf>.

A.V. Kasture and S.G. Wadodkar, Pharmaceutical Chemistry—II: Second Year Diploma in Pharmacy, Nirali Prakashan, p. 339, 2007.

Adeeb, et al., "*An Inductive Link-Based Wireless Power Transfer System for Biomedical Applications," Research Article*, Nov. 14, 2011, pp. 1-12, vol. 2012, Article ID 879294, Hindawi Publishing Corporation.

Allegro MicroSystems, LLC, Automotive Full Bridge MOSFET Driver, A3941-DS, Rev. 5, 21 pages, http://www.allegromicro.com/~/media/Files/Datasheets/A3941-Datasheet.ashx?la=en.

Anonymous, Analog Devices Wiki, Chapter 11: The Current Mirror, Aug. 20, 2017, 22 pages. https://wiki.analog.com/university/courses/electronics/text/chapter-11?rev=1503222341.

Anonymous: "Sense & Control Application Note Current Sensing Using Linear Hall Sensors," Feb. 3, 2009, pp. 1-18. Retrieved from the Internet: URL: http://www.infineon.com/dgdl/Current_Sensing_Rev.1.1.pdf?fileId=db3a304332d040720132d939503e5f17 [retrieved on Oct. 18, 2016].

Arrow Sign Icon Next Button, by Blan-k, shutterstock.com [online], published on or before Aug. 6, 2014, [retrieved on Jun. 4, 2019], retrieved from the Internet [URL:https://www.shutterstock.com/de/image-vector/arrow-sign-icon-next-button-navigation-207700303?irgwc=1&utm . . . see PDF in file for full URL] (Year: 2014).

ASTM procedure D2240-00, "Standard Test Method for Rubber Property-Durometer Hardness," (Published Aug. 2000).

ASTM procedure D2240-05, "Standard Test Method for Rubber Property-Durometer Hardness," (Published Apr. 2010).

B.R. Coolman, DVM, MS et al., "Comparison of Skin Staples With Sutures for Anastomosis of the Small Intestine in Dogs," Abstract; http://www.blackwell-synergy.com/doi/abs/10.1053/jvet.2000.7539?cookieSet=1&journalCode=vsu which redirects to http://www3.interscience.wiley.com/journal/119040681/abstract?CRETRY=1&SRETRY=0; [online] accessed: Sep. 22, 2008 (2 pages).

Brar et al., "Investigation of the mechanical and degradation properties of Mg—Sr and Mg—Zn—Sr alloys for use as potential biodegradable implant materials," J. Mech. Behavior of Biomed. Mater. 7 (2012) pp. 87-95.

Breedveld et al., "A New, Easily Miniaturized Sterrable Endoscope," IEEE Engineering in Medicine and Biology Magazine (Nov./Dec. 2005).

Byrne et al., "Molecular Imprinting Within Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 149-161.

C.C. Thompson et al., "Peroral Endoscopic Reduction of Dilated Gastrojejunal Anastomosis After Roux-en-Y Gastric Bypass: A Possible New Option for Patients with Weight Regain," Surg Endosc (2006) vol. 20., pp. 1744-1748.

Chen et al., "Elastomeric Biomaterials for Tissue Engineering," Progress in Polymer Science 38 (2013), pp. 584-671.

Covidien "iDrive™ Ultra Powered Stapling System, A Guide for Surgeons," (6 pages).

Covidien "iDrive™ Ultra Powered Stapling System, Cleaning and Sterilization Guide," (2 pages).

Covidien Brochure "iDrive™ Ultra Powered Stapling System," (6 pages).

Covidien Brochure, "Endo GIA™ Curved Tip Reload with Tri-Staple™ Technology," (2012), 2 pages.

Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology and Endo GIA™ Ultra Universal Staplers," (2010), 2 pages.

Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology," (2010), 1 page.

Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology," (2010), 2 pages.

Covidien Brochure, "Endo GIA™ Black Reload with Tri-Staple™ Technology," (2012), 2 pages.

Covidien Brochure, "Endo GIA™ Ultra Universal Stapler," (2010), 2 pages.

Covidien iDrive™ Ultra in Service Reference Card, "iDrive™ Ultra Powered Stapling Device," (4 pages).

Covidien iDrive™ Ultra Powered Stapling System ibrochure, "The Power of iDrive™ Ultra Powered Stapling System and Tri-Staple™ Technology," (23 pages).

Cuper et al., "The Use of Near-Infrared Light for Safe and Effective Visualization of Subsurface Blood Vessels to Facilitate Blood Withdrawal in Children," Medical Engineering & Physics, vol. 35, No. 4, pp. 433-440 (2013).

D. Tuite, Ed., "Get the Lowdown on Ultracapacitors," Nov. 15, 2007; [online] URL: http://electronicdesign.com/Articles/Print.cfm?ArticleID-17465, accessed Jan. 15, 2008 (5 pages).

Data Sheet of LM4F230H5QR, 2007.

Datasheet for Panasonic TK Relays Ultra Low Profile 2 A Polarized Relay, Copyright Matsushita Electric Works, Ltd. (Known of at least as early as Aug. 17, 2010), 5 pages.

Disclosed Anonymously, "Motor-Driven Surgical Stapler Improvements," Research Disclosure Database No. 526041, Published: Feb. 2008.

Ebara, "Carbohydrate-Derived Hydrogels and Microgels," Engineered Carbohydrate-Based Materials for Biomedical Applications: Polymers, Surfaes, Dendrimers, Nanoparticles, and Hydrogels, Edited by Ravin Narain, 2011, pp. 337-345.

Elite Icons, by smart/icons, iconfinder.com [online], published on Aug. 18, 2016, [retrieved on Jun. 4, 2019], retrieved from the Internet [URL: https://www.iconfinder.com/iconsets/elite] (Year: 2016).

Fast, Versatile Blackfin Processors Handle Advanced RFID Reader Applications; Analog Dialogue: vol. 40—Sep. 2006; http://www.analog.com/library/analogDialogue/archives/40-09/rfid.pdf; Wayback Machine to Feb. 15, 2012.

Fischer, Martin H, "Colloid-Chemical Studies on Soaps", The Chemical Engineer, pp. 184-193, Aug. 1919.

Forum discussion regarding "Speed Is Faster", published on Oct. 1, 2014 and retrieved on Nov. 8, 2019 from URL https://english.stackexchange.com/questions/199018/how-is-that-correct-speed-is-faster-or-prices-are-cheaper (Year: 2014).

Gao et al., "Mechanical Signature Enhancement of Response Vibrations in the Time Lag Domain," Fifth International Congress on Sound and Vibration, Dec. 15-18, 1997, pp. 1-8.

Hoffman, "Hydrogels for Biomedical Applications," Advanced Drug Delivery Reviews, 43 (2002) pp. 3-12.

Hoffman, "Hydrogels for Biomedical Applications," Advanced Drug Delivery Reviews, 54 (2002) pp. 3-12.

Honda HS1332AT and ATD Model Info, powerequipment.honda.com [online], published on or before Mar. 22, 2016, [retrieved on

(56) **References Cited**

OTHER PUBLICATIONS

May 31, 2019], retrieved from the Internet [URL: https://powerequipment.honda.com/snowblowers/models/hss1332at-hss1332atd] {Year: 2016).

http://ninpgan.net/publications/51-100/89.pdf; 2004, Ning Pan, On Uniqueness of Fibrous Materials, Design & Nature II. Eds: Colins, M. and Brebbia, C. WIT Press, Boston, 493-504.

Jeong et al., "Thermosensitive Sol-Gel Reversible Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 37-51.

Kawamura, Atsuo, et al. "Wireless Transmission of Power and Information Through One High-Frequency Resonant AC Link Inverter for Robot Manipulator Applications," Journal, May/Jun. 1996, pp. 503-508, vol. 32, No. 3, IEEE Transactions on Industry Applications.

Lee, Youbok, "Antenna Circuit Design for RFID Applications," 2003, pp. 1-50, DS00710C, Microchip Technology Inc., Available: http://ww1.microchip.com/downloads/en/AppNotes/00710c.pdf.

Lyon et al. "The Relationship Between Current Load and Temperature for Quasi-Steady State and Transient Conditions," SPIE—International Society for Optical Engineering. Proceedings, vol. 4020, (pp. 62-70), Mar. 30, 2000.

Matsuda, "Thermodynamics of Formation of Porous Polymeric Membrane from Solutions," Polymer Journal, vol. 23, No. 5, pp. 435-444 (1991).

Miyata et al., "Biomolecule-Sensitive Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 79-98.

Mouser Electronics, "LM317 3-Terminal Adjustable Regulator with Overcurrent/Overtemperature Self Protection", Sep. 30, 2016 (Sep. 30, 2016), XP0555246104, Retrieved from the Internet: URL: http://www.mouser.com/ds/2/405/lm317m-440423.pdf, pp. 1-9.

Mouser Electronics, "LM317M 3-Terminal Adjustable Regulator with Overcurrent/Overtemperature Self Protection", Mar. 31, 2014 (Mar. 31, 2014), XP0555246104, Retrieved from the Internet: URL: http://www.mouser.com/ds/2/405/lm317m-440423.pdf, pp. 1-8.

NF Monographs: Sodium Stearate, U.S. Pharmacopeia, http://www.pharmacopeia.cn/v29240/usp29nf24s0_m77360.html, accessed May 23, 2016.

Patrick J. Sweeney: "RFID for Dummies", Mar. 11, 2010, pp. 365-365, XP055150775, ISBN: 978-1-11-805447-5, Retrieved from the Internet: URL: books.google.de/books?isbn=1118054474 [retrieved on Nov. 4, 2014]—book not attached.

Pellicer et al. "On the biodegradability, mechanical behavior, and cytocompatibility of amorphous Mg72Zn23Ca5 and crystalline Mg70Zn23Ca5Pd2 alloys as temporary implant materials," J Biomed Mater Res Part A ,2013:101A:502-517.

Peppas, "Physiologically Responsive Hydrogels," Journal of Bioactive and Compatible Polymers, vol. 6 (Jul. 1991) pp. 241-246.

Peppas, Editor "Hydrogels in Medicine and Pharmacy," vol. I, Fundamentals, CRC Press, 1986.

Pitt et al., "Attachment of Hyaluronan to Metallic Surfaces," J. Biomed. Mater. Res. 68A: pp. 95-106, 2004.

Qiu et al., "Environment-Sensitive Hydrogels for Drug Delivery," Advanced Drug Delivery Reviews, 53 (2001) pp. 321-339.

Qiu Li Loh et al.: "Three-Dimensional Scaffolds for Tissue Engineering Applications: Role of Porosity and Pore Size", Tissue Engineering Part B—Reviews, vol. 19, No. 6, Dec. 1, 2013, pp. 485-502.

Schellhammer et al., "Poly-Lactic-Acid for Coating of Endovascular Stents: Preliminary Results in Canine Experimental Av-Fistulae," Mat.-wiss. u. Werkstofftech., 32, pp. 193-199 (2001).

Schroeter, John, "*Demystifying UHF Gen 2 RFID, HF RFID," Online Article*, Jun. 2, 2008, pp. 1-3, <https://www.edn.com/desion/industrial-control/4019123/Demystifying-UHF-Gen-2-RFID-HF-RFID>.

Seils et al., Covidien Summary: Clinical Study "UCONN Biodynamics: Final Report on Results," (2 pages).

Serial Communication Protocol; Michael Lemmon Feb. 1, 2009; http://www3.nd.edu/~lemmon/courses/ee224/web-manual/web-manual/lab12/node2.html; Wayback Machine to Apr. 29, 2012.

Slow Safety Sign, shutterstock.com [online], published on or before May 9, 2017, [retrieved on May 31, 2019], retrieved from the https://www.shutterstock.com/image-victor/slow-safety-sign-twodimensional-turtle-symbolizing- . . . see PDF in file for full URL] (Year: 2017).

Solorio et al., "Gelatin Microspheres Crosslinked with Genipin for Local Delivery of Growth Factors," J. Tissue Eng. Regen. Med. (2010), 4(7): pp. 514-523.

Texas Instruments: "Current Recirculation and Decay Modes," Application Report SLVA321—Mar. 2009; Retrieved from the Internet: URL:http://www.ti.com/lit/an/slva321/slva321 [retrieved on Apr. 25, 2017], 7 pages.

The Sodem Aseptic Battery Transfer Kit, Sodem Systems, 2000, 3 pages.

Trendafilova et al., "Vibration-based Methods for Structural and Machinery Fault Diagnosis Based on Nonlinear Dynamics Tools," In: Fault Diagnosis in Robotic and Industrial Systems, IConcept Press Ltd, 2012, pp. 1-29.

V.K. Ahluwalia and Madhuri Goyal, A Textbook of Organic Chemistry, Section 19.11.3, p. 356, 2000.

Van Meer et al., "A Disposable Plastic Compact Wrist for Smart Minimally Invasive Surgical Tools," LAAS/CNRS (Aug. 2005).

Warning Sign Beveled Buttons, by Peter, flarestock.com [online], published on or before Jan. 1, 2017, [retrieved on Jun. 4, 2019], retrieved from the Internet [URL: https://www.flarestock.com/stock-images/warning-sign-beveled-buttons/70257] (Year: 2017).

Yan et al, Comparison of the effects of Mg—6Zn and Ti—3Al—2.5V alloys on TGF-β/TNF-α/VEGF/b-FGF in the healing of the intestinal track in vivo, Biomed. Mater. 9 (2014), 11 pages.

Yan et al., "Comparison of the effects of Mg—6Zn and titanium on intestinal tract in vivo," J Mater Sci: Mater Med (2013), 11 pages.

Young, "Microcellular foams via phase separation," Journal of Vacuum Science & Technology A 4(3), (May/Jun. 1986).

Youtube.com; video by Fibran (retrieved from URL https://www.youtube.com/watch?v=vN2Qjt51gFQ); (Year: 2018).

* cited by examiner

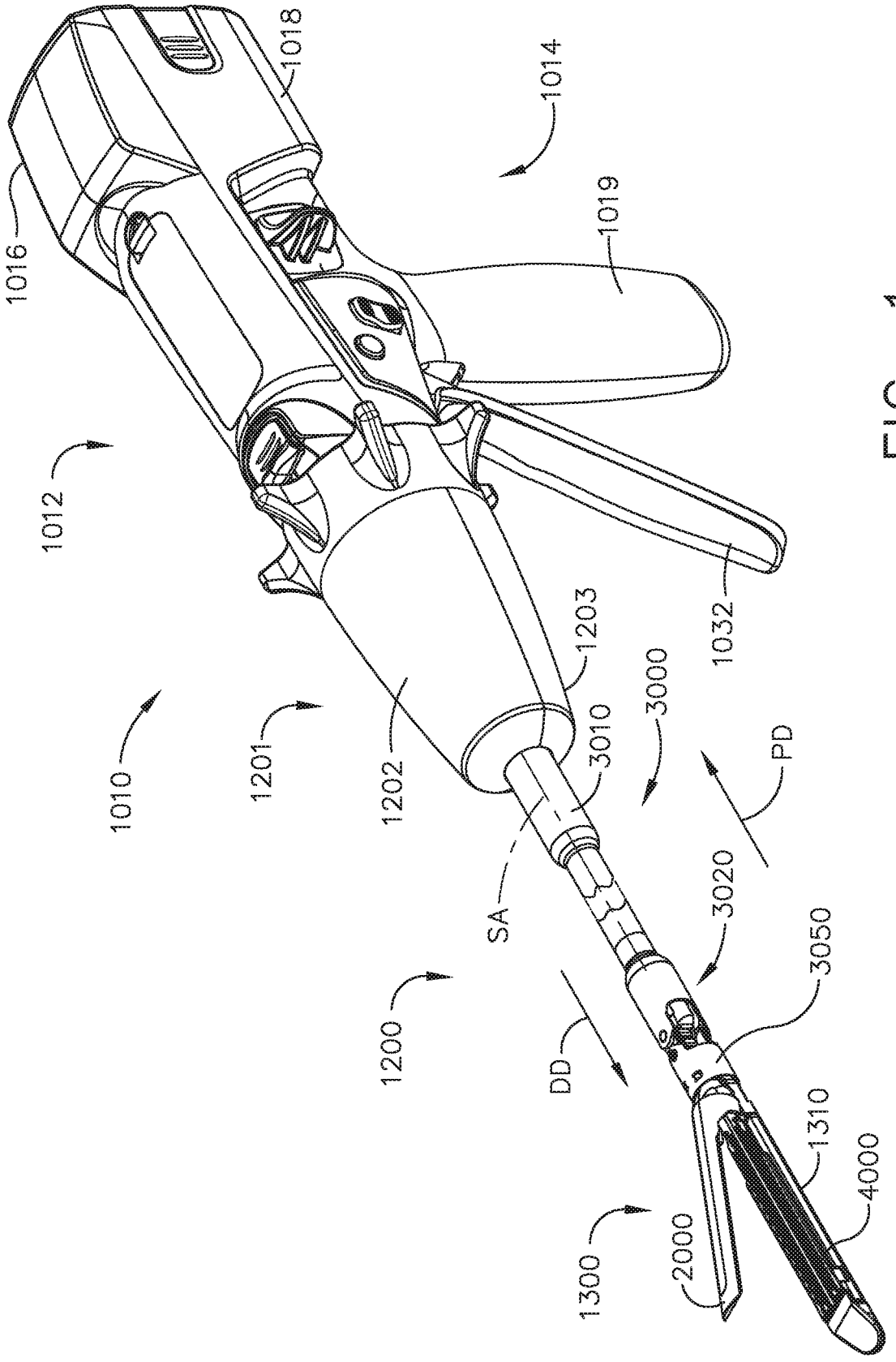

1018
1014
1016
1019
1012
1032
1203
3000
1010
1201
1202
3010
PD
SA
3020
3050
1200
DD
1310
4000
1300
2000

FIG. 1

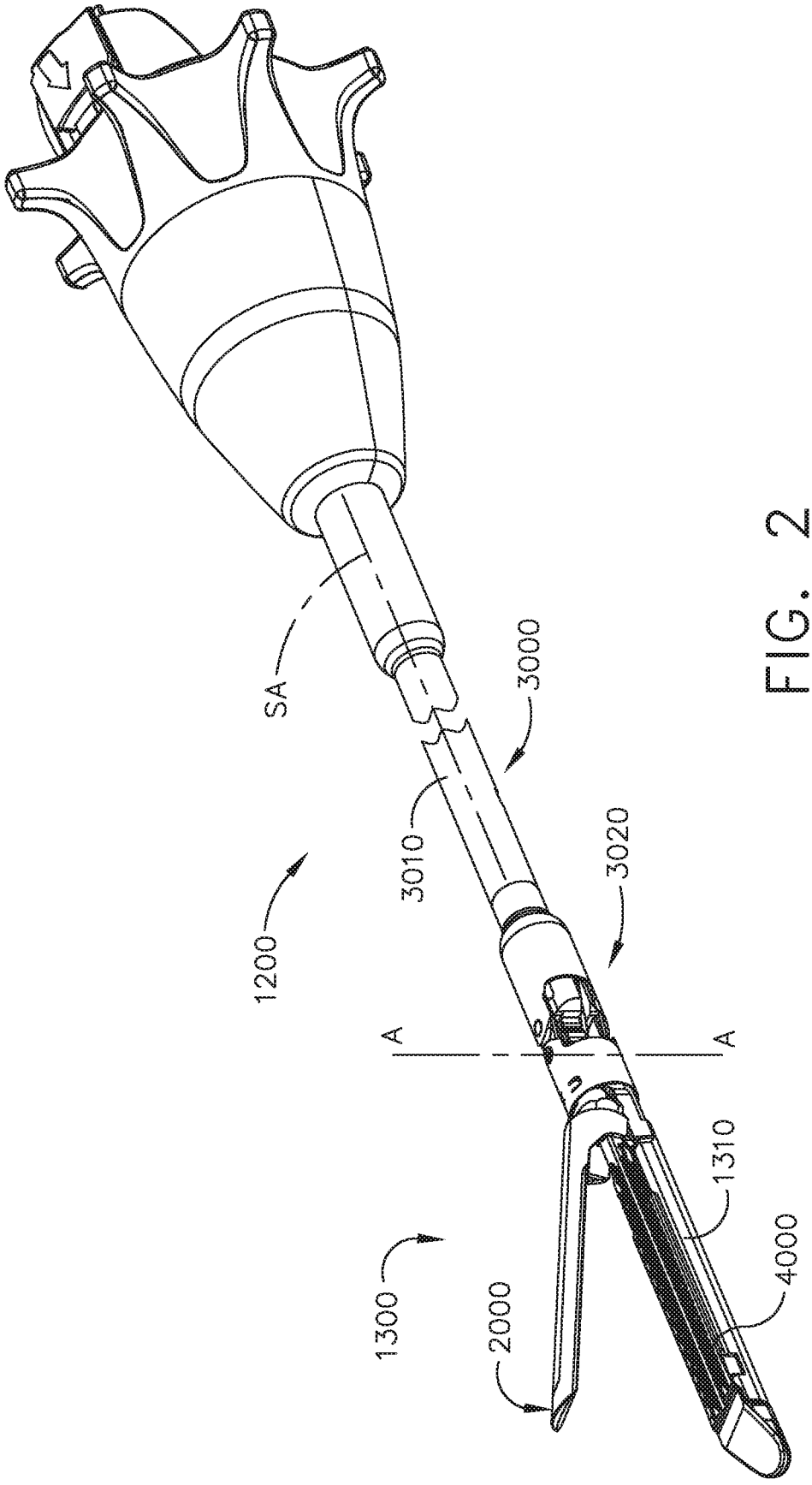


FIG. 2

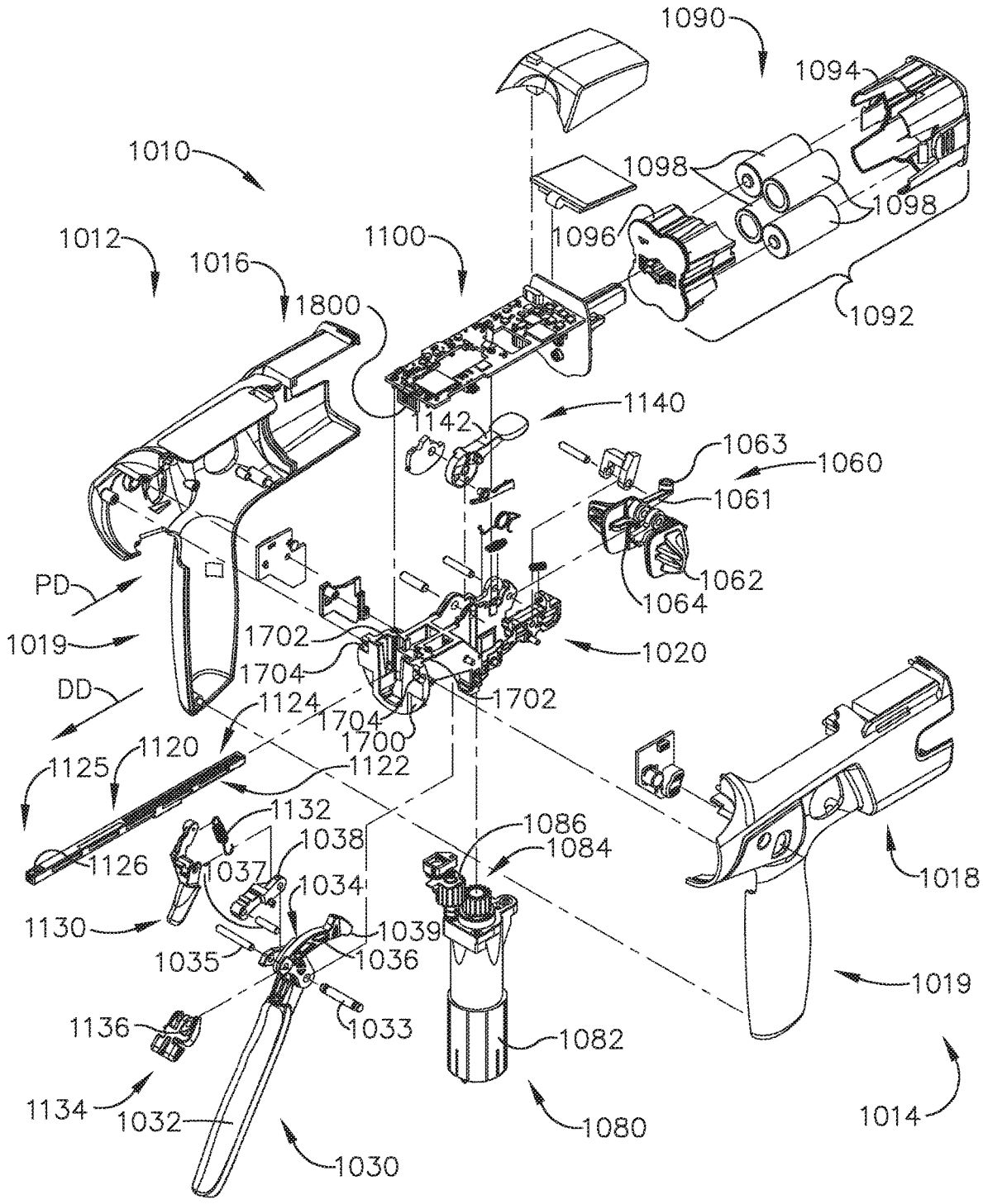

1090
1094
1010
1098
1098
1012
1016
1100
1096
1800
1092
1140
1142
1063
1060
1061
PD
1062
1064
1019
1702
1020
1704
DD
1124
1702
1704
1700
1120
1125
1122
1132
1086
1038
1084
1126
1037
1034
1018
1130
1039
1035
1036
1019
1136
1033
1082
1134
1032
1080
1014
1030

FIG. 3

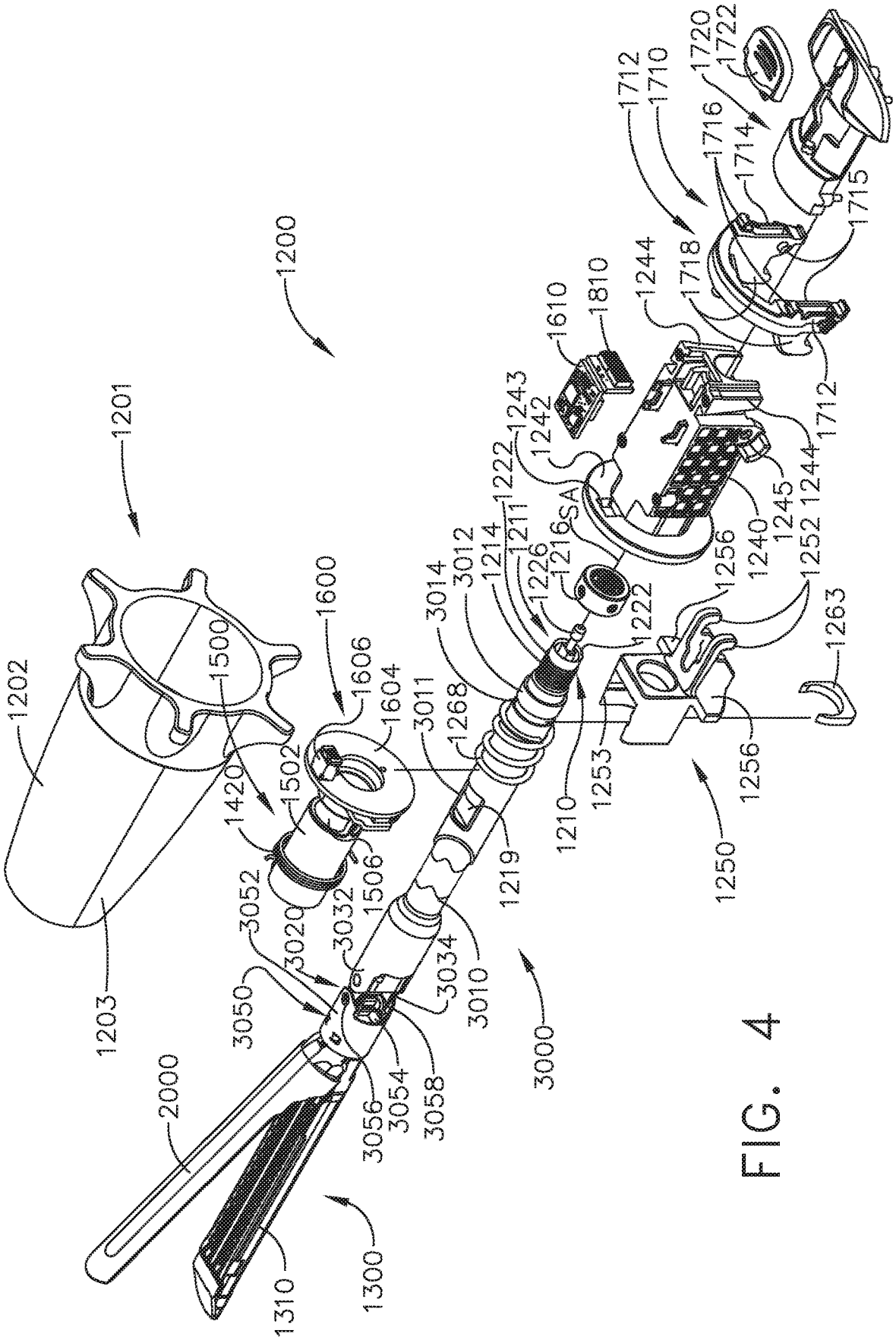

1200
1201
1202
1203
1300
1310
2000
3000
1500
1600
1606
1604
1502
1420
3052
3020
3032
1506
3050
3056
3054
3058
3034
3010
3011
1268
3014
3012
1214
1211
1226
1216SA
1222
1219
1210
1253
1256
1250
1263
1252
1240
1245
1244
1242
1243
1222
1610
1810
1244
1718
1712
1710
1716
1714
1720
1722
1715
1712

FIG. 4

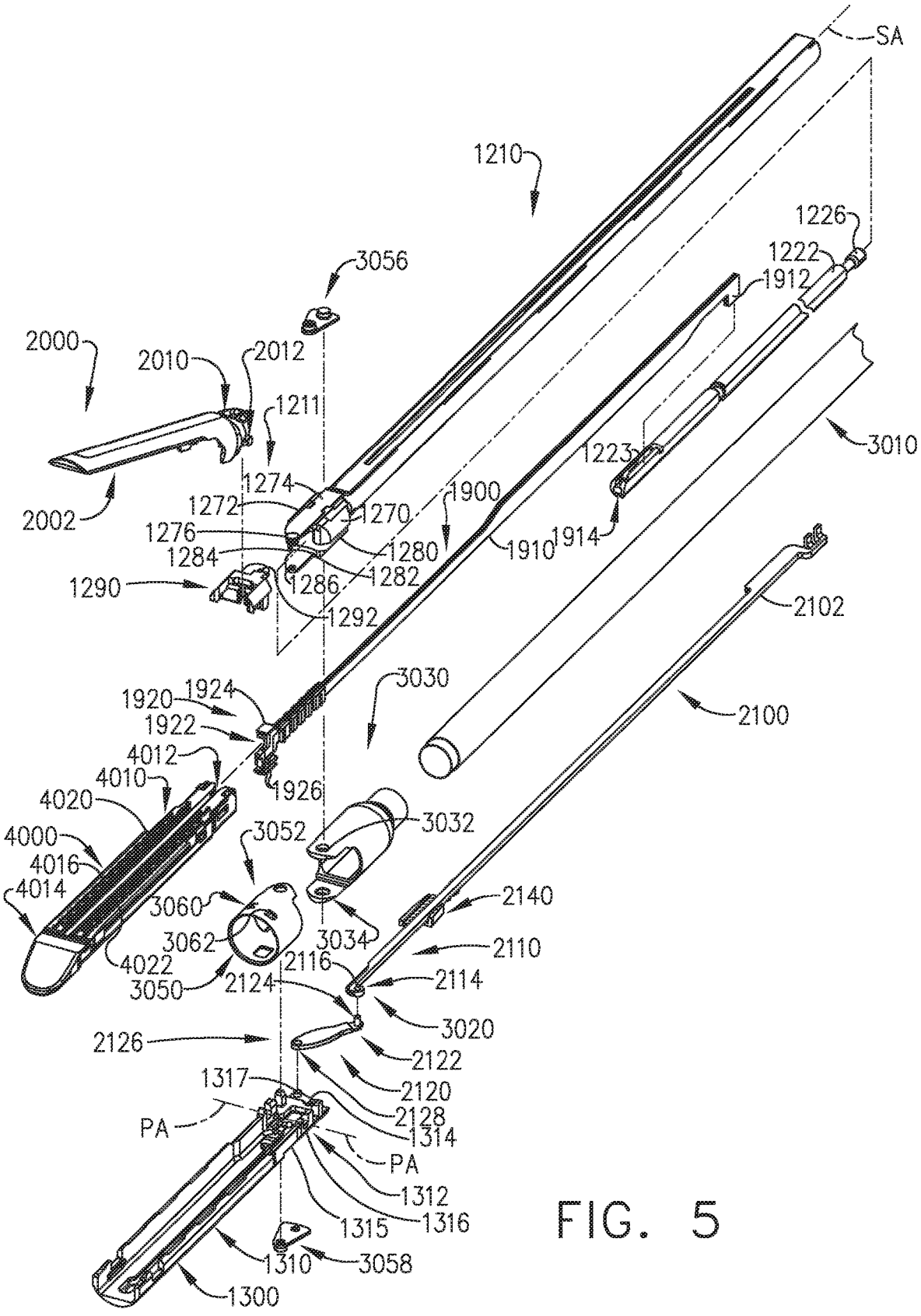

SA
1210
1226
1222
1912
3056
2000
2010
2012
1211
1223
3010
1274
1272
1270
1900
2002
1276
1280
1910
1914
1284
1282
1290
1286
1292
2102
3030
1920
1924
1922
2100
4012
4010
1926
4020
3032
3052
4000
4016
4014
2140
3060
3034
3062
2110
4022
2116
2114
3050
2124
3020
2126
2122
1317
2120
2128
PA
1314
PA
1312
1315
1316
1310
3058
1300

FIG. 5

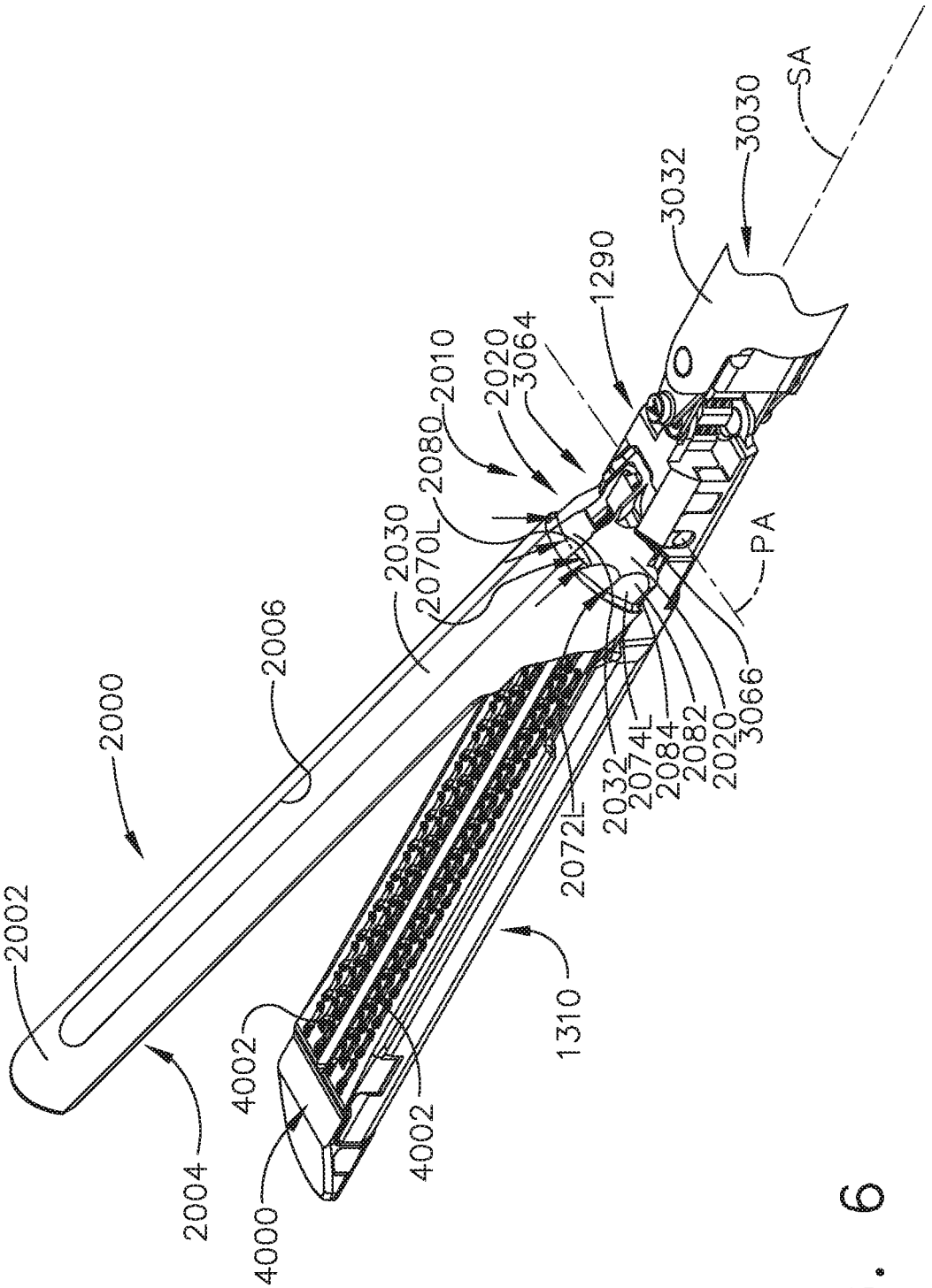

2002
2000
2006
2004
4000
4002
4002
1310
2072L
2032
2074L
2084
2082
2020
3066
PA
2030
2070L
2080
2010
2020
3064
1290
3032
3030
SA

FIG. 6

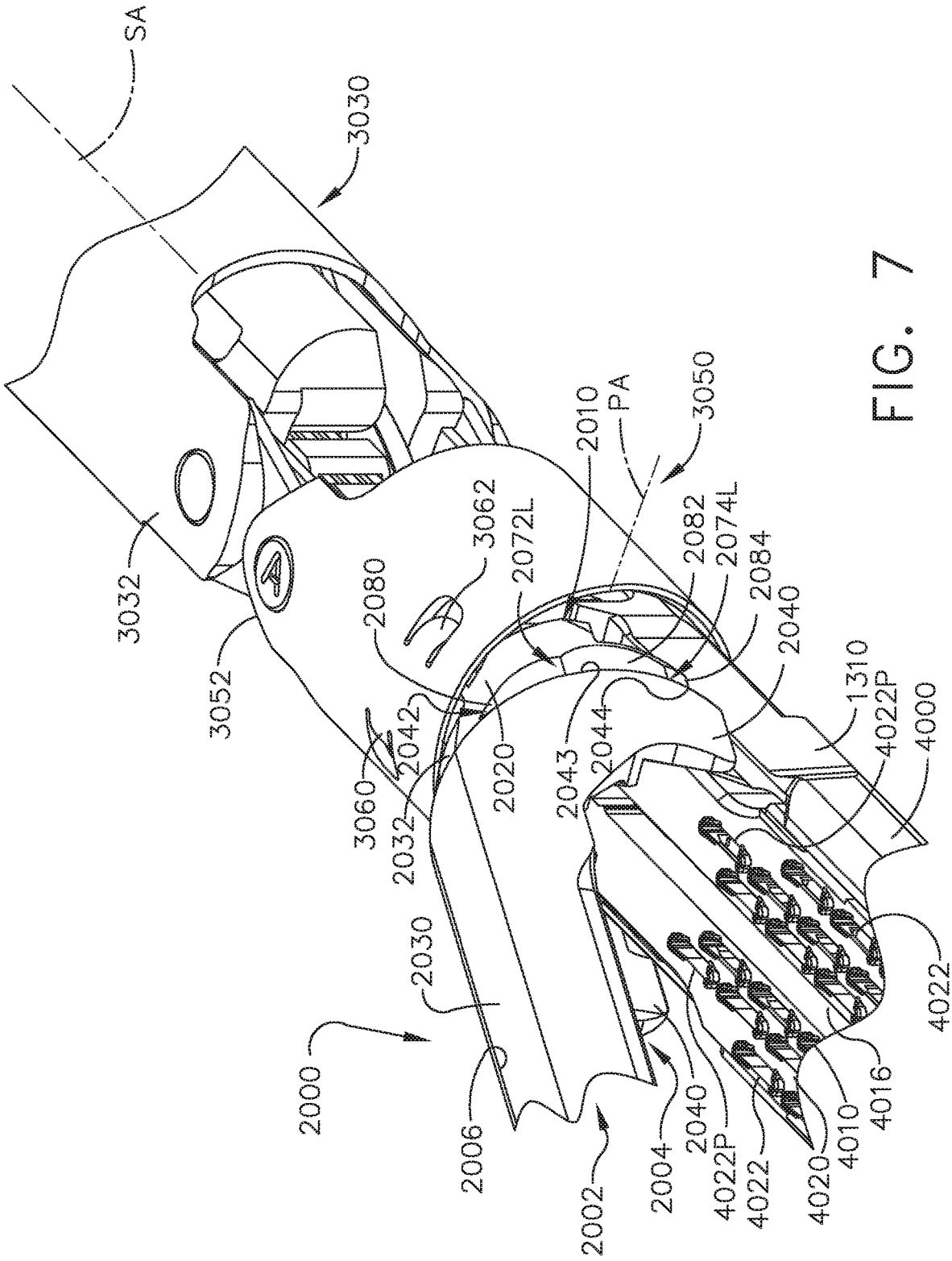

SA
3030
3032
3052
3062
2072L
2080
2010
PA
3050
2082
2074L
2084
2040
1310
4022P
4000
4022
4016
4010
4020
4022
4022P
2040
2004
2002
2006
2000
2030
2032
3060
2042
2020
2043
2044

FIG. 7

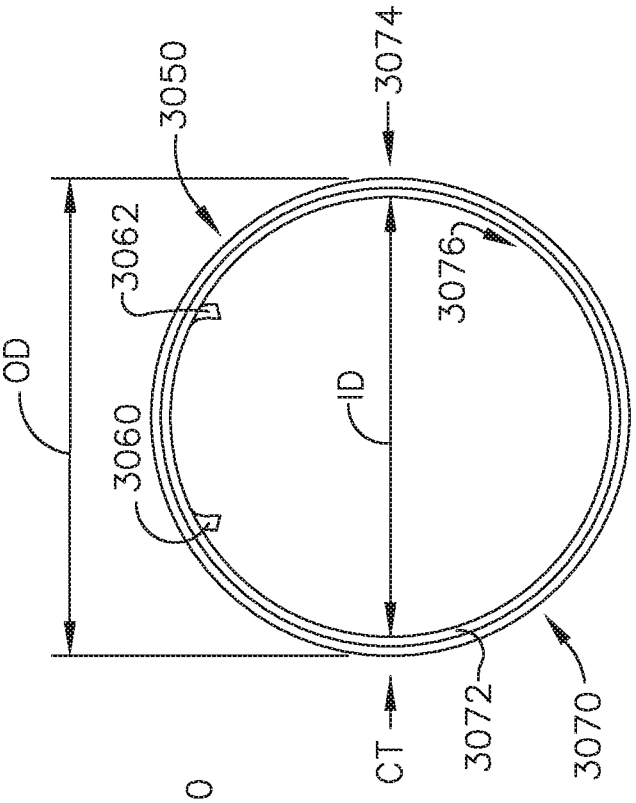

3050
3074
3062
3076
OD
ID
3060
CT
3072
3070

FIG. 9

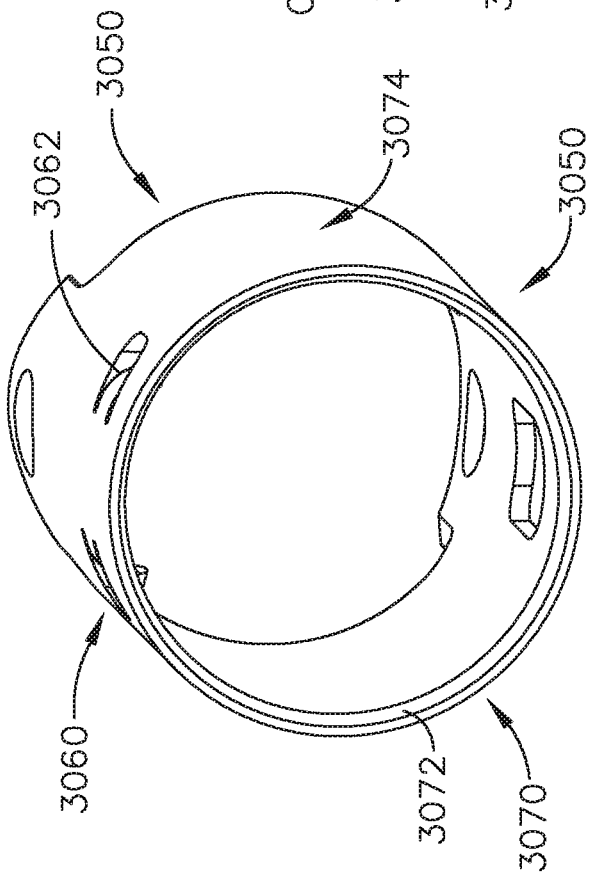

3050
3062
3074
3050
3060
3072
3070

FIG. 8

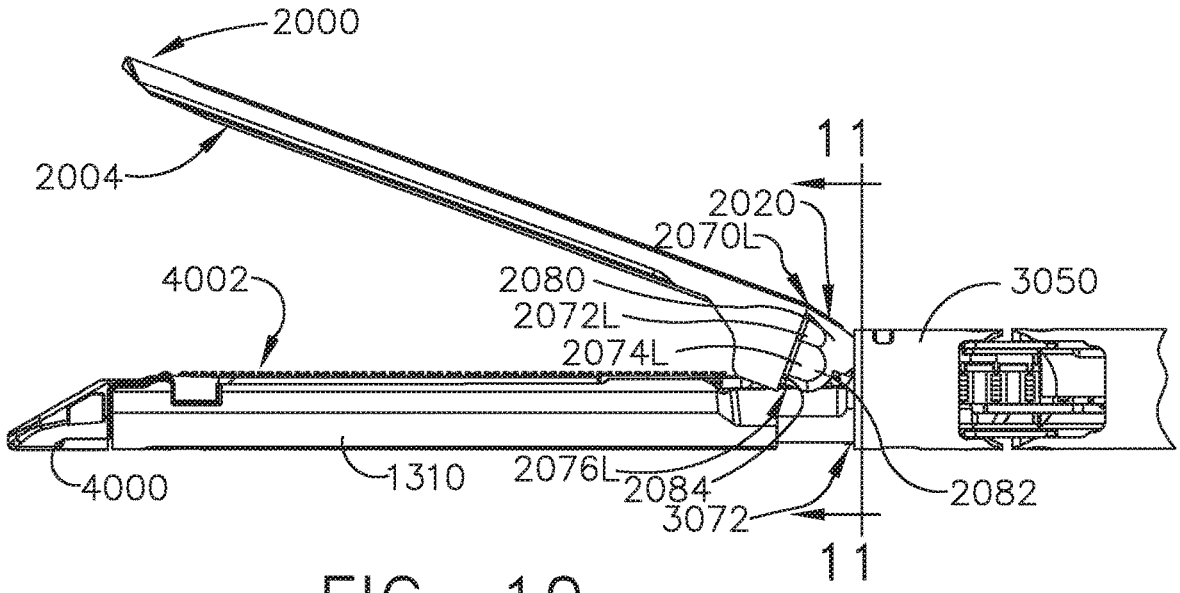


FIG. 10

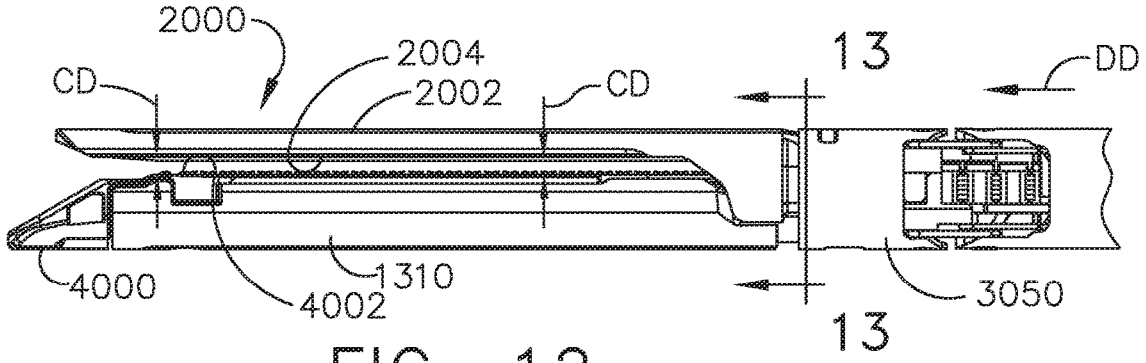


FIG. 12

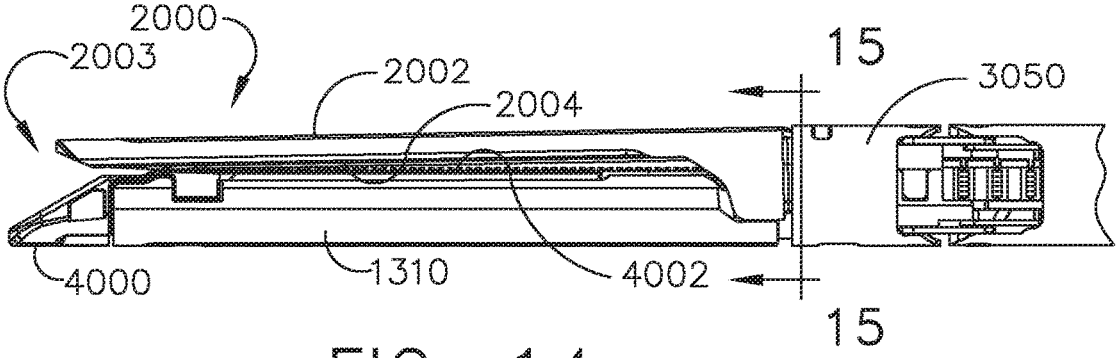


FIG. 14

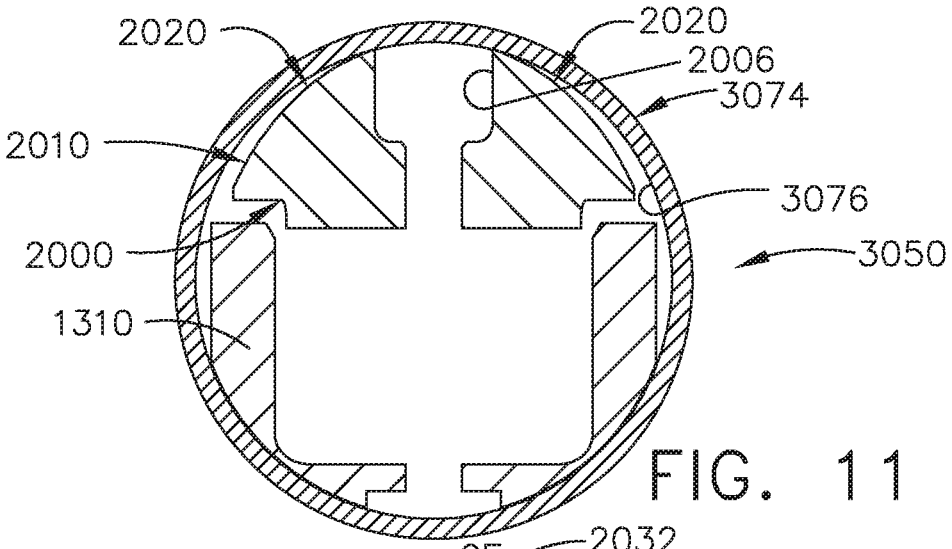


FIG. 11

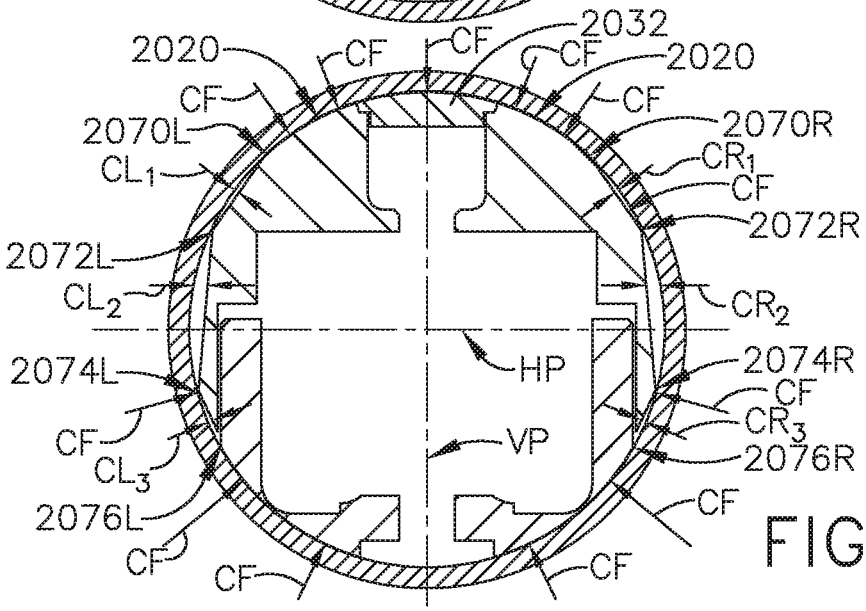


FIG. 13

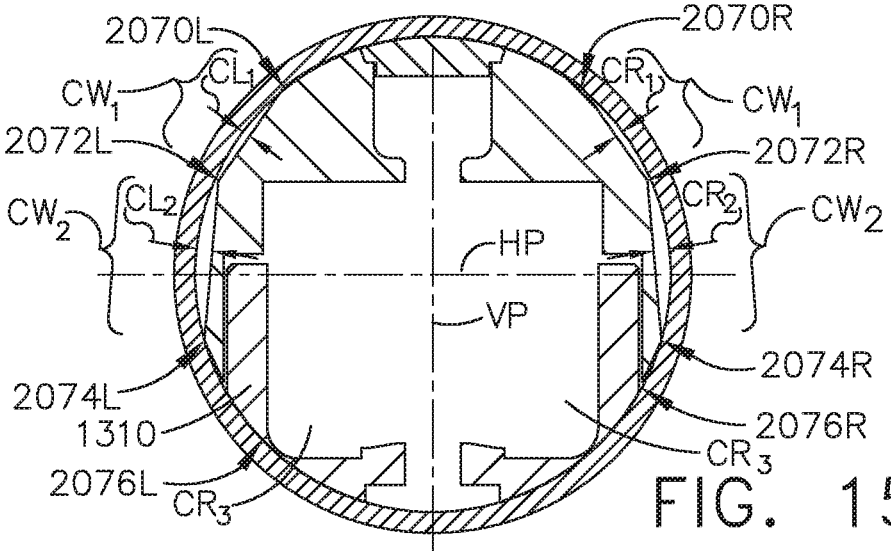


FIG. 15

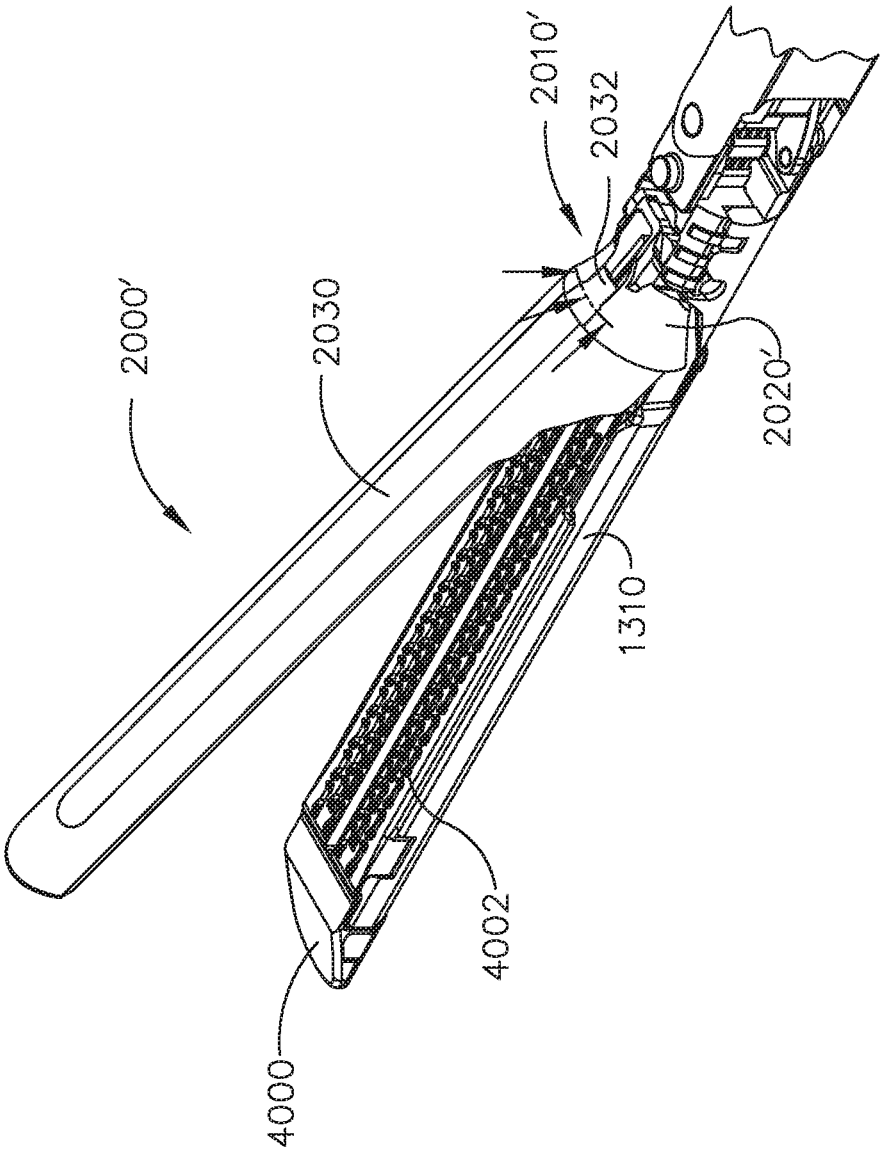


FIG. 16

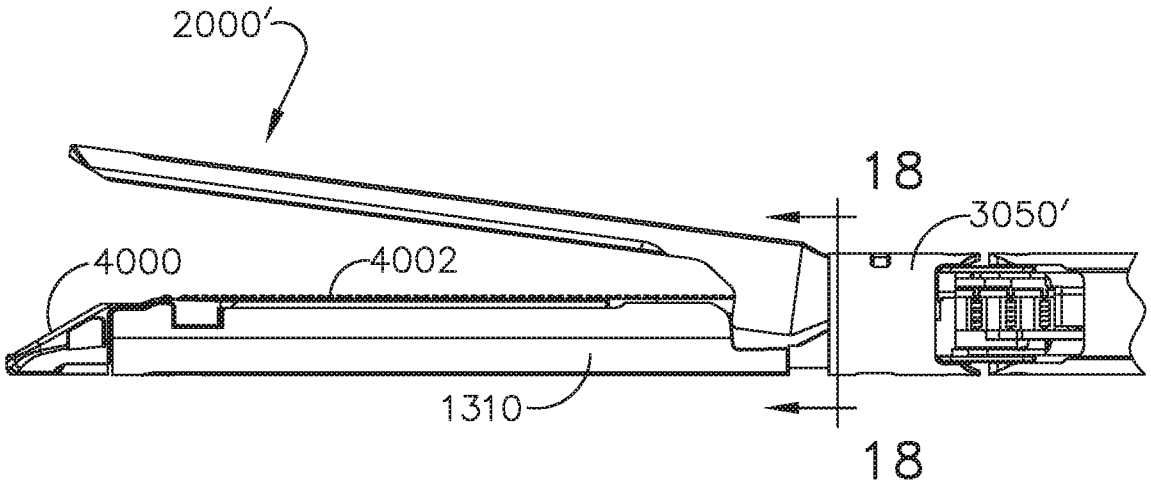


FIG. 17

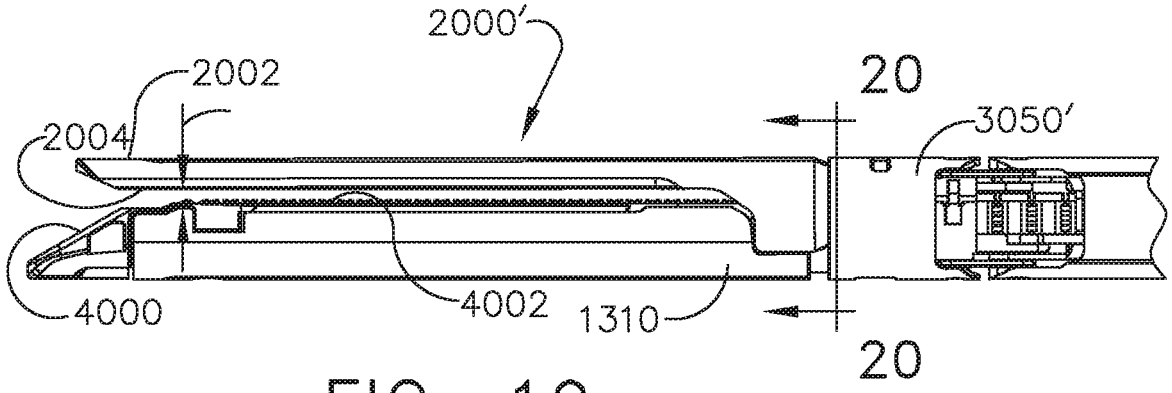


FIG. 19

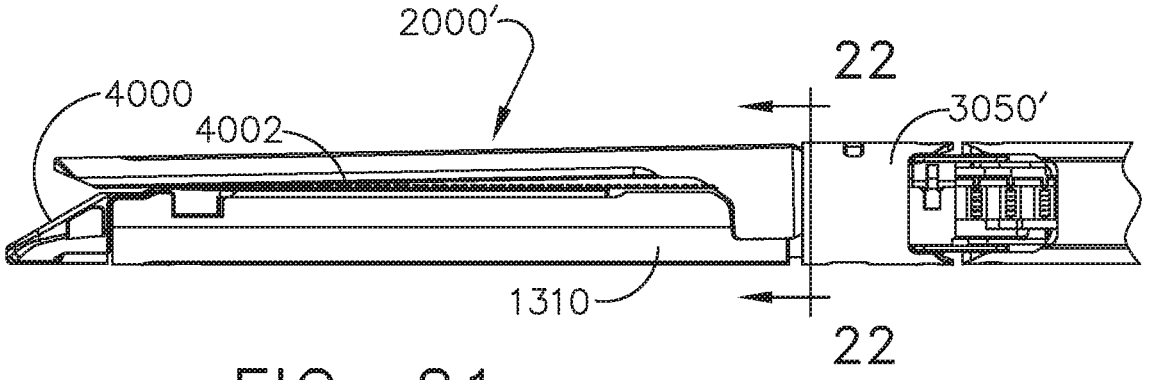


FIG. 21

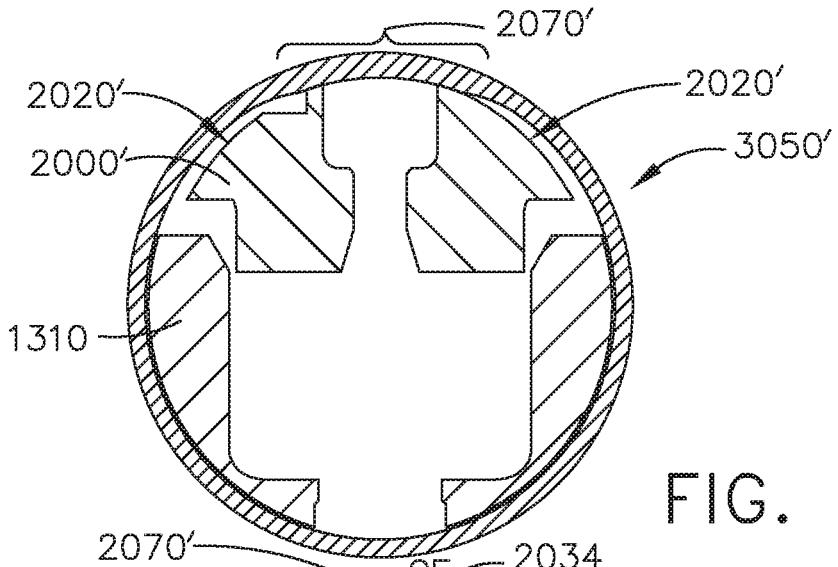


FIG. 18

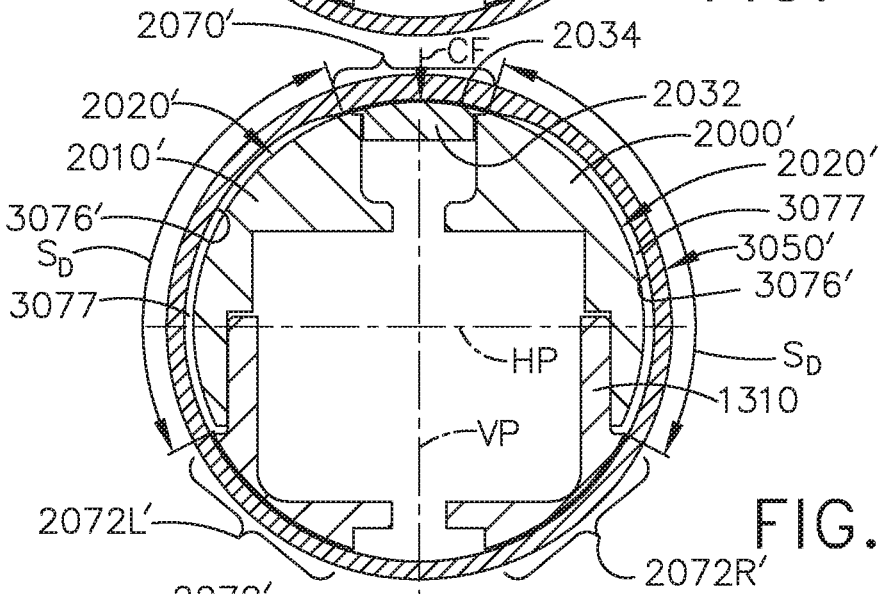


FIG. 20

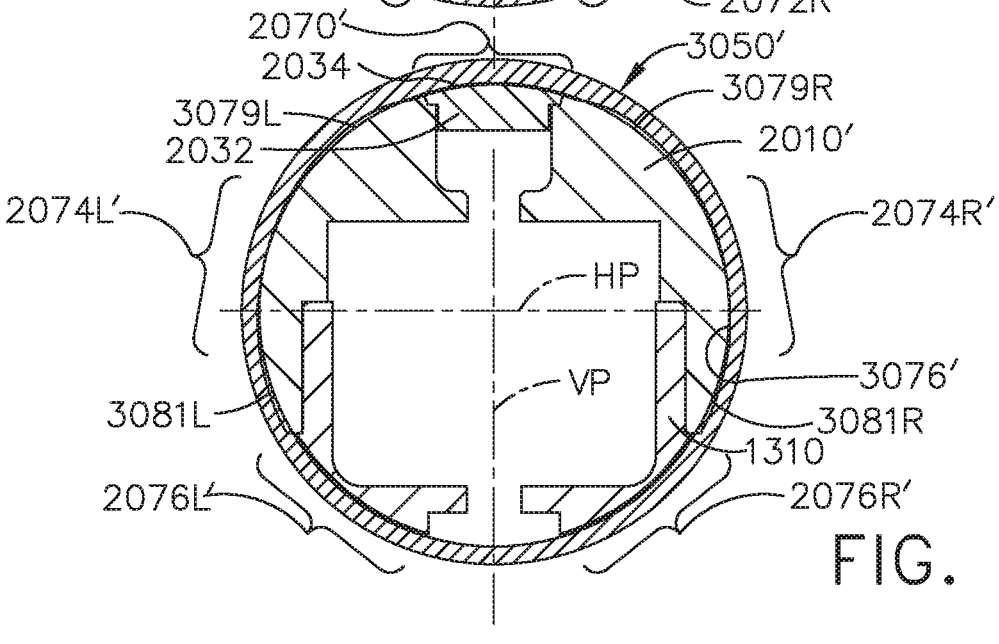


FIG. 22

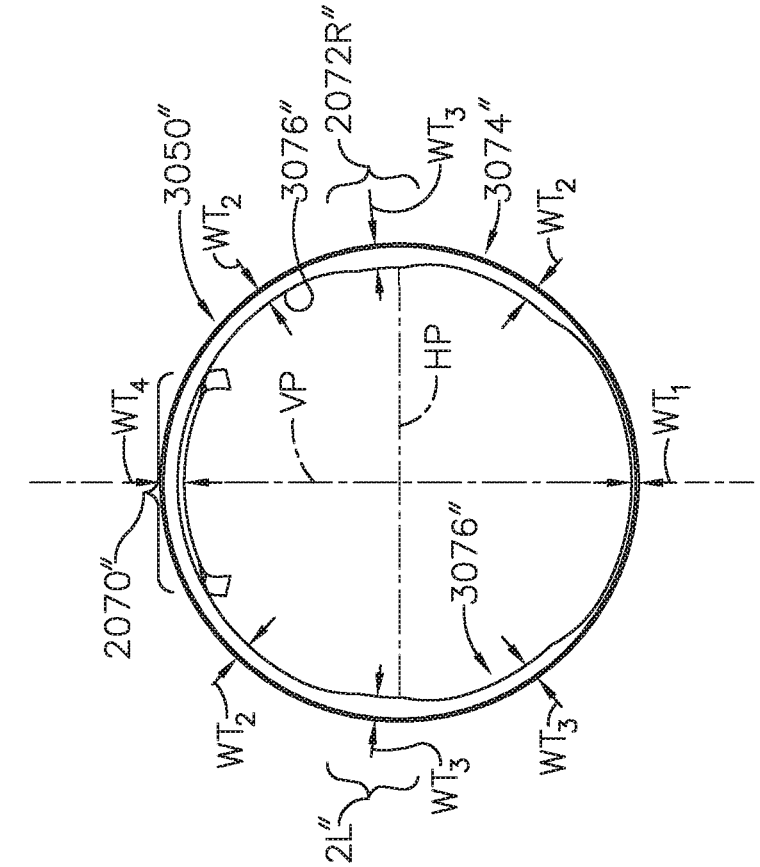

3050″
WT2
3076″
2072R″
WT3
3074″
WT2
HP
VP
WT1
WT4
2070″
3076″
WT2
WT3
WT3
2072L″

FIG. 30

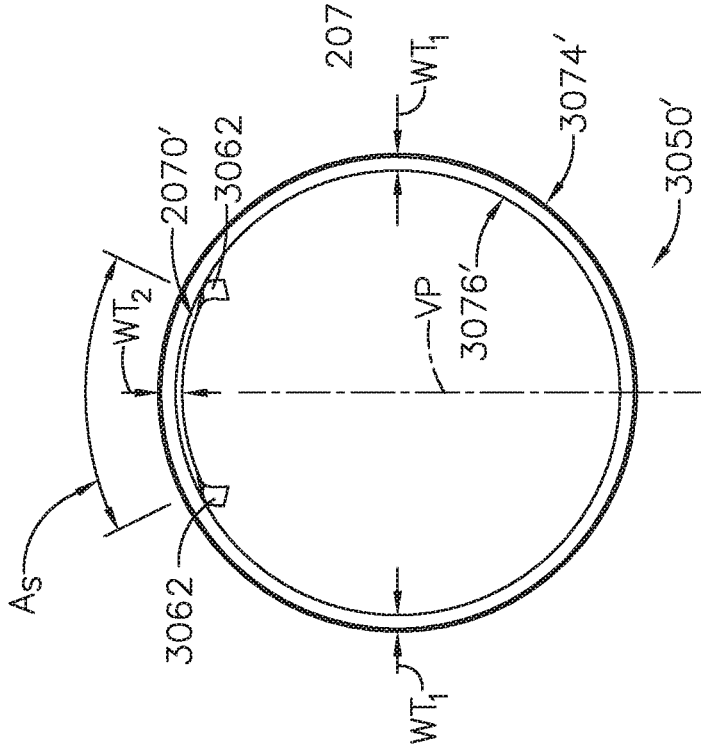

WT1
3074′
3050′
2070′
3062
VP
3076′
WT2
As
3062
WT1

FIG. 23

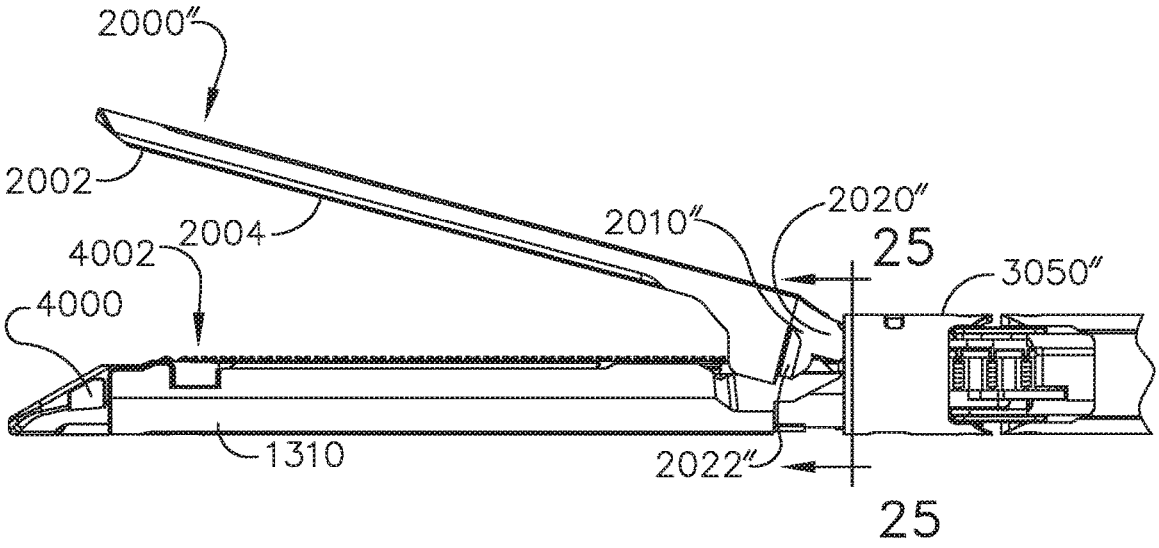


FIG. 24

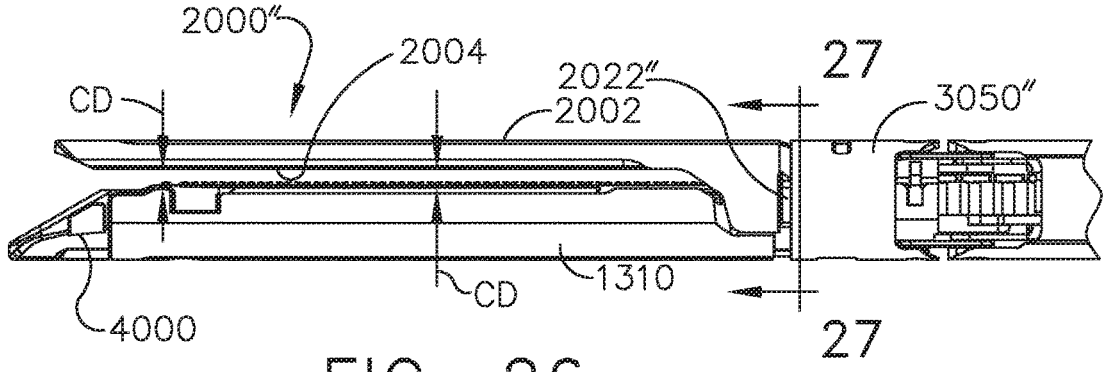


FIG. 26

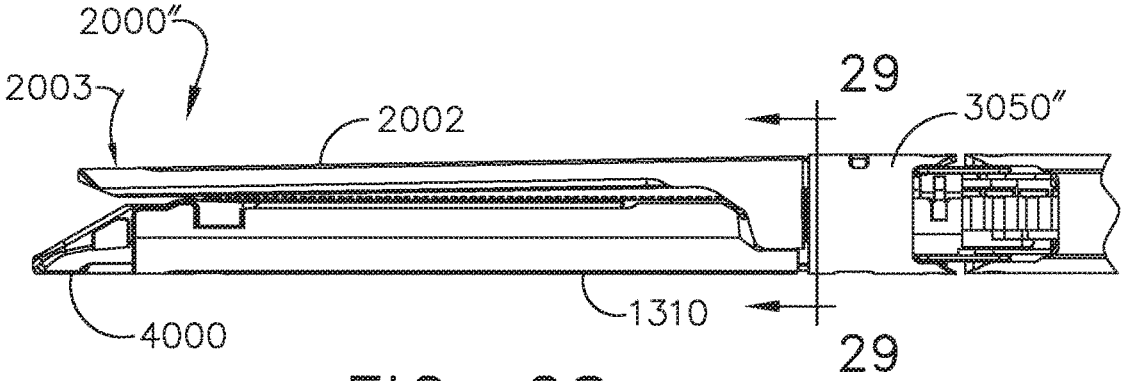


FIG. 28

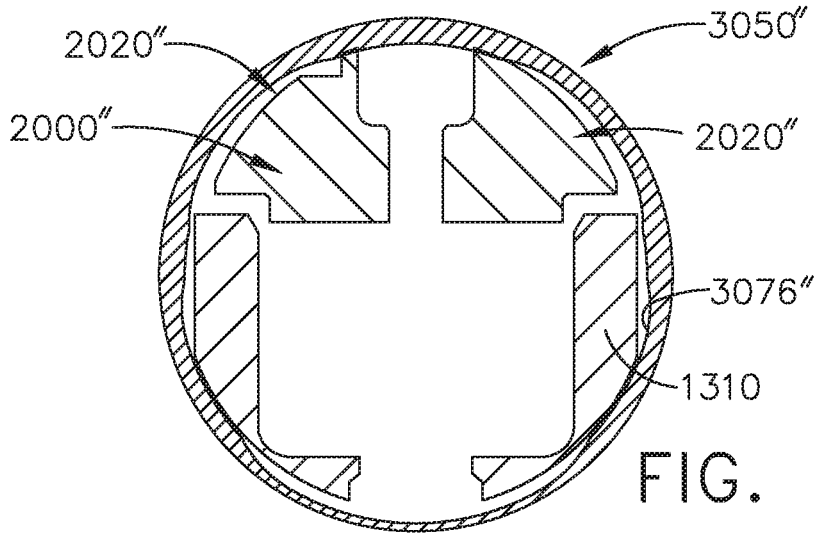


FIG. 25

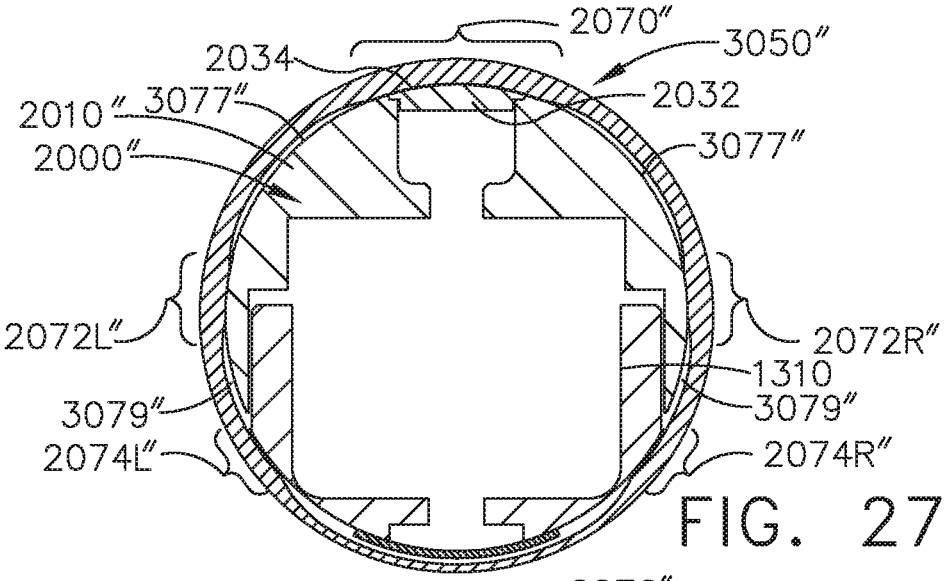


FIG. 27

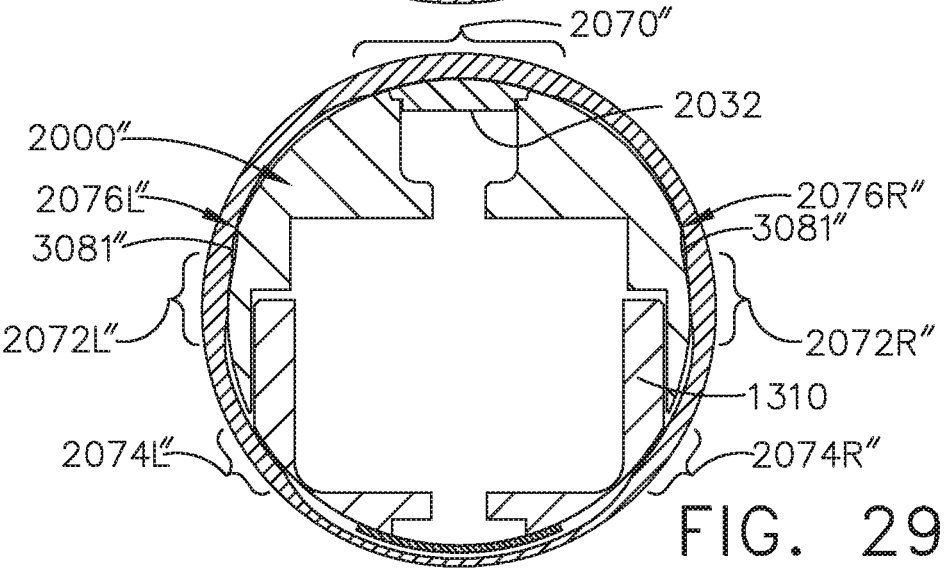


FIG. 29

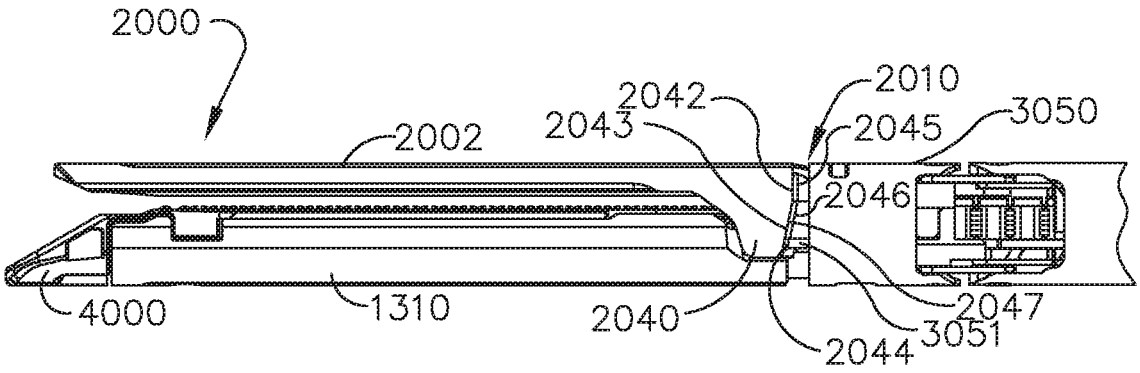

2000
2002
2042
2043
2010
2045
3050
2046
4000
1310
2040
2047
3051
2044

FIG. 31

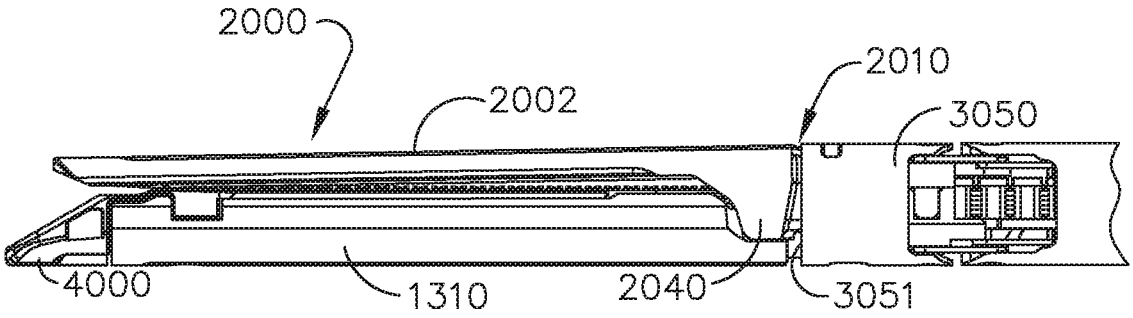

2000
2002
2010
3050
4000
1310
2040
3051

FIG. 32

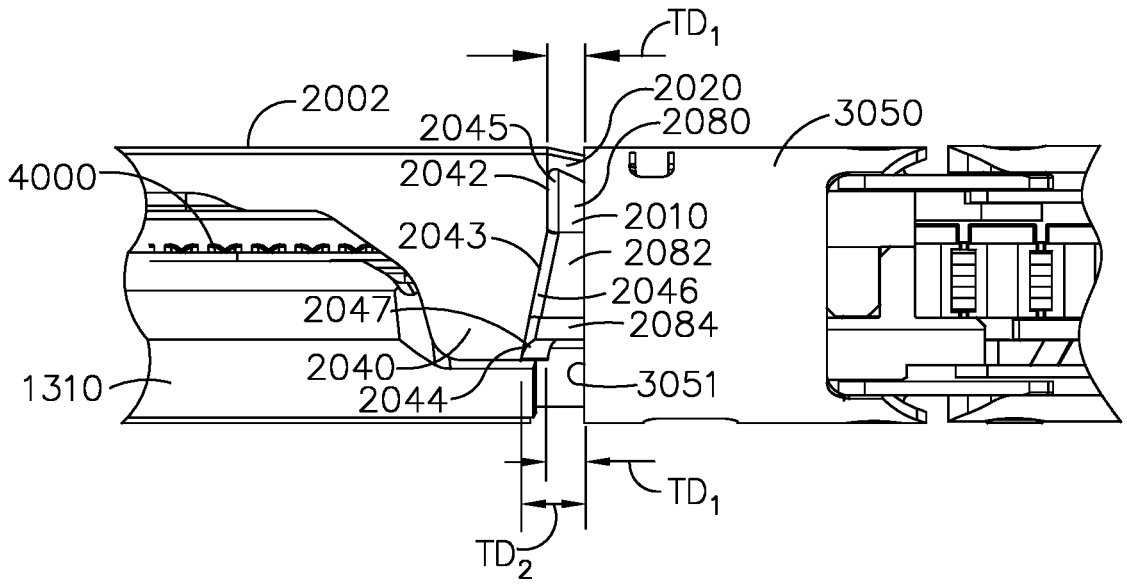

TD1
2002
2020
2045
2080
3050
4000
2042
2010
2043
2082
2046
2047
2084
2040
3051
1310
2044
TD1
TD2

FIG. 33

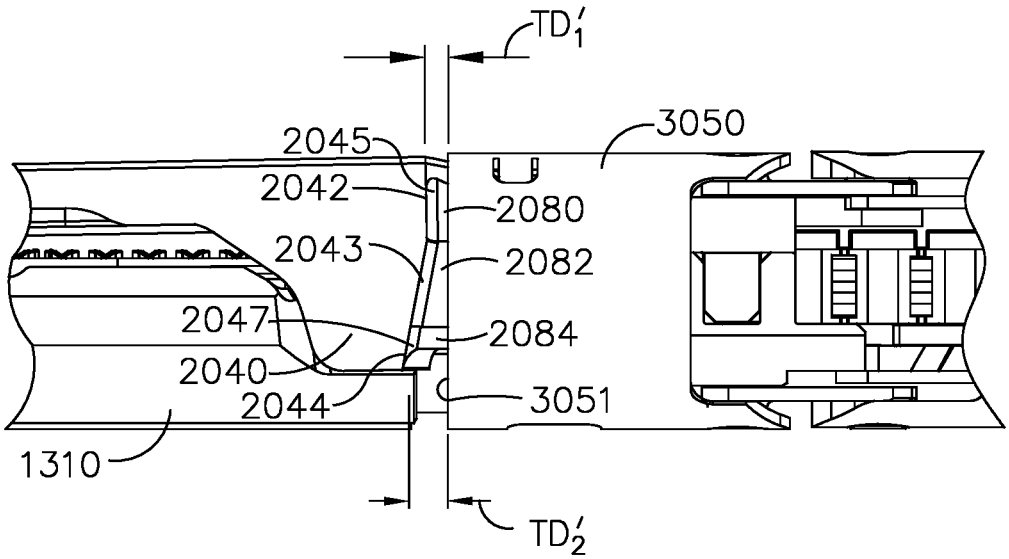

TD1'
3050
2045
2042
2080
2043
2082
2047
2084
2040
3051
2044
1310
TD2'

FIG. 34

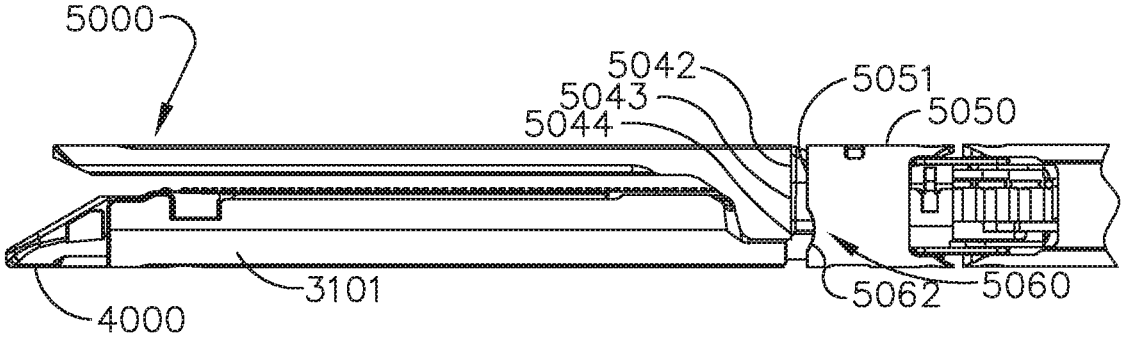

5000
5042
5043
5044
5051
5050
3101
4000
5062
5060

FIG. 35

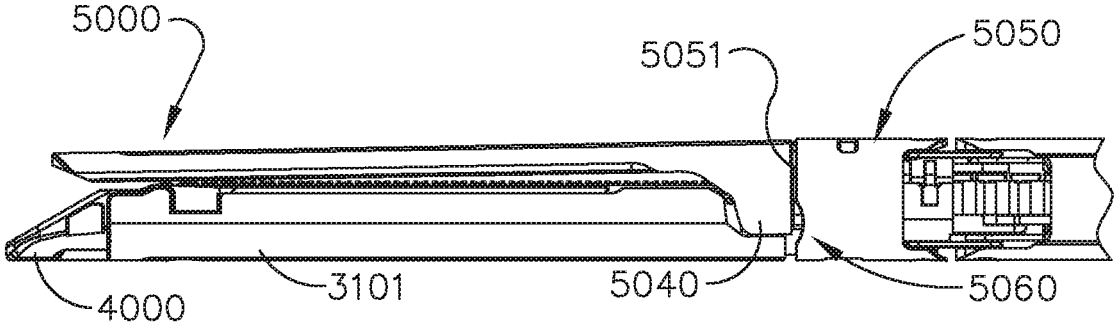

5000
5051
5050
3101
4000
5040
5060

FIG. 37

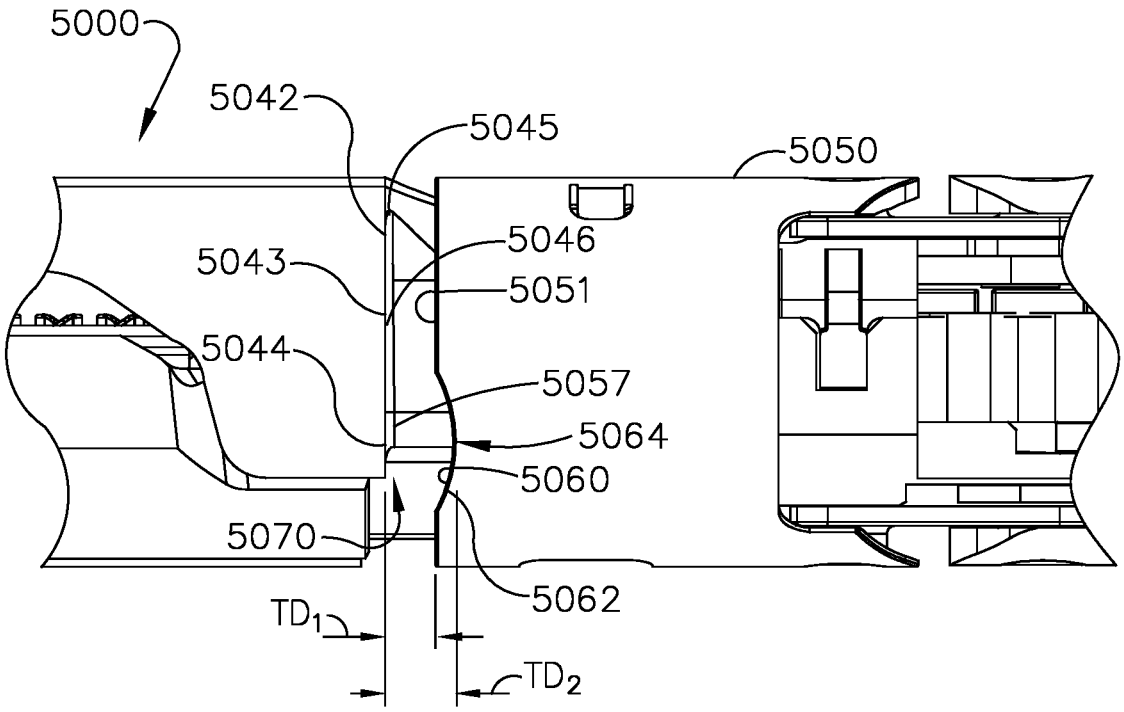

5000
5042
5045
5050
5046
5043
5051
5044
5057
5064
5060
5070
5062
TD1
TD2

FIG. 36

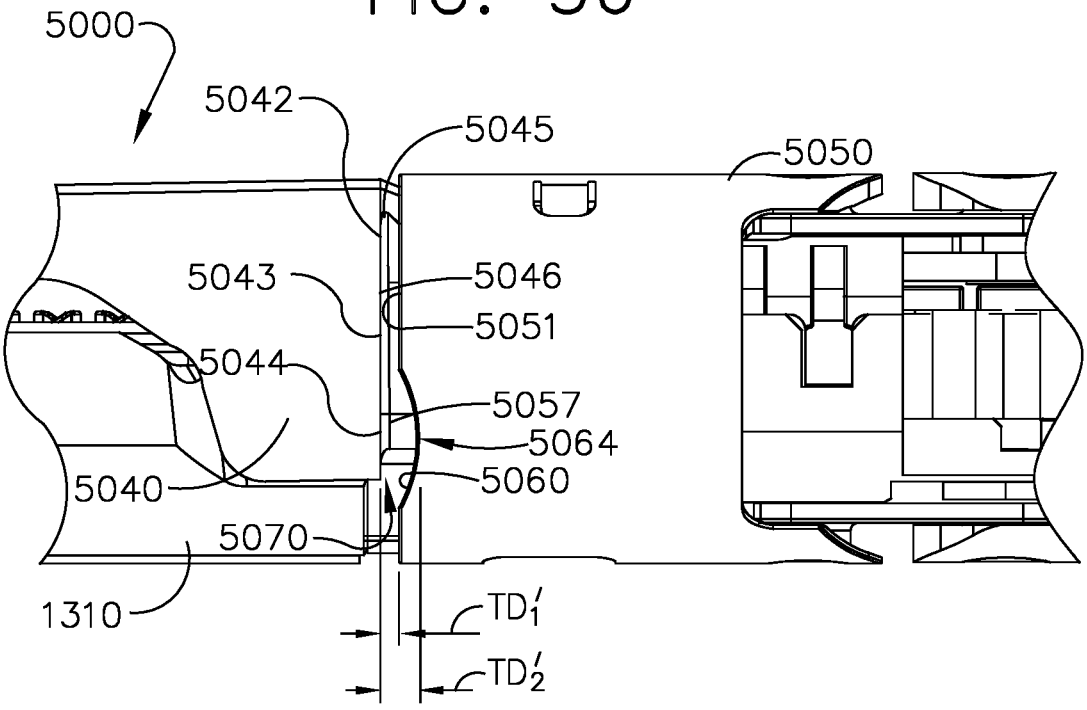

5000
5042
5045
5050
5043
5046
5051
5044
5057
5064
5040
5060
5070
1310
TD1'
TD2'

FIG. 38

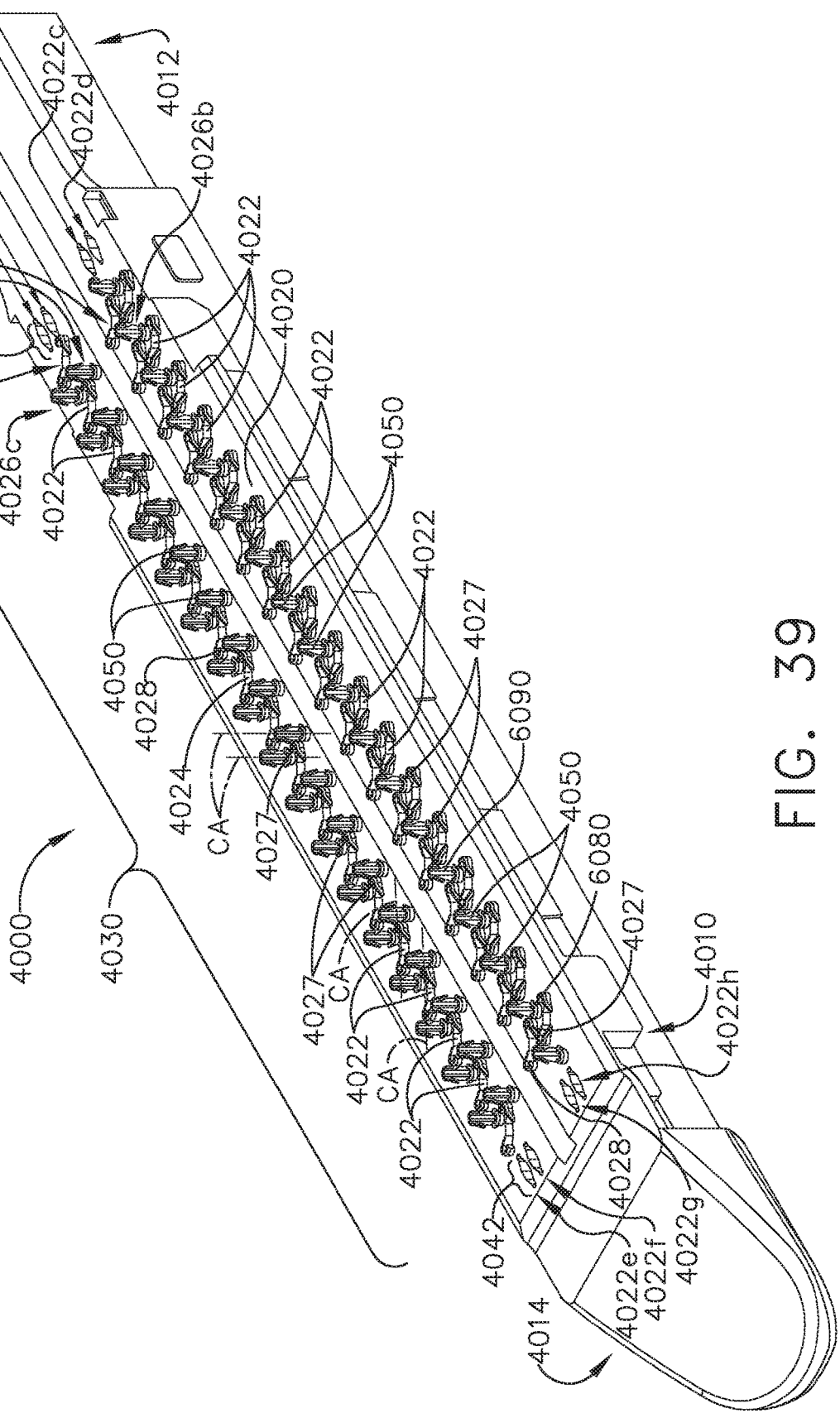

4000
4030
4020
4016
4022b
4022a
4026a
4040
4026b
4026c
4022
4022c
4022d
4012
4026b
4022
4020
4022
4050
4022
4027
6090
4050
6080
4027
4010
4022h
4028
4022g
4022f
4022e
4014
4042
4050
4028
4024
CA
4027
4027
CA
4022
CA
4022
SCA

FIG. 39

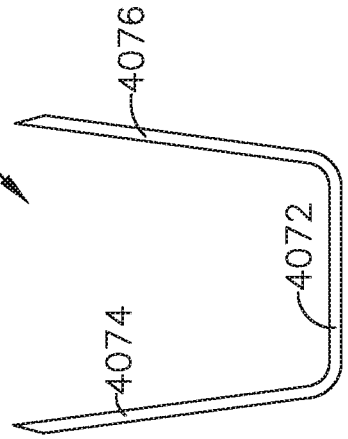


FIG. 42

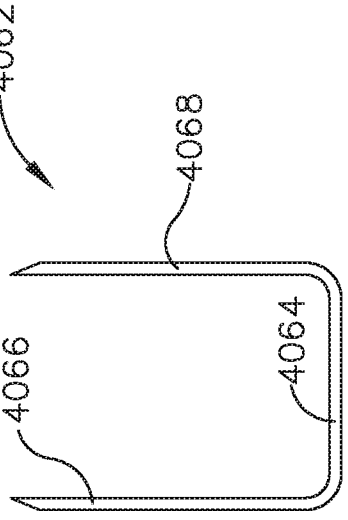


FIG. 41

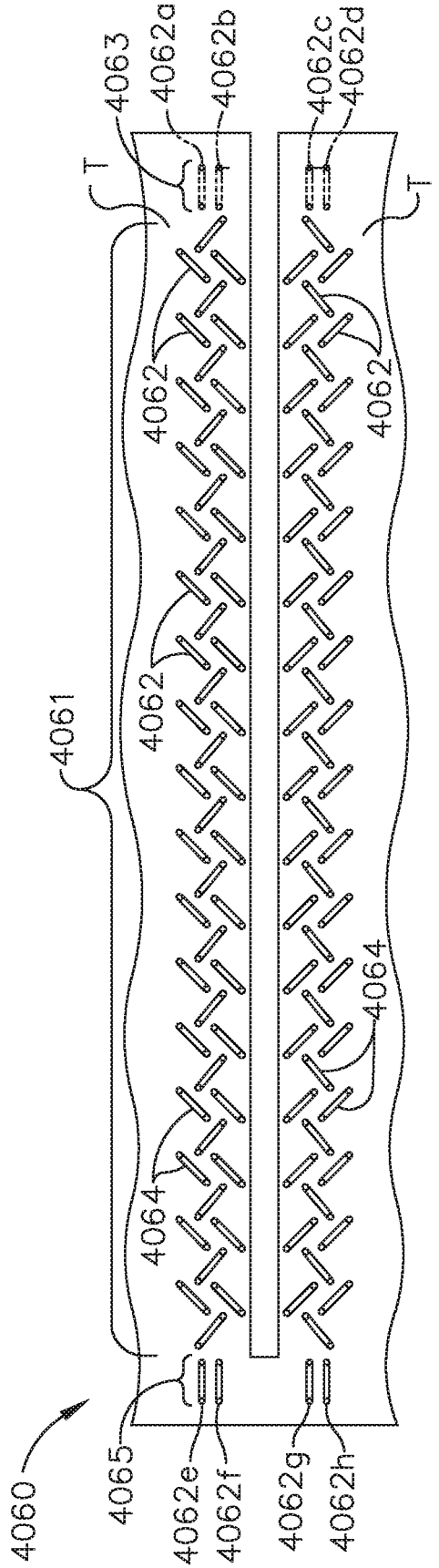


FIG. 40

SURGICAL STAPLER ANVILS WITH TISSUE STOP FEATURES CONFIGURED TO AVOID TISSUE PINCH

BACKGROUND

The present invention relates to surgical instruments and, in various arrangements, to surgical stapling and cutting instruments and staple cartridges for use therewith that are designed to staple and cut tissue.

BRIEF DESCRIPTION OF THE DRAWINGS

Various features of the embodiments described herein, together with advantages thereof, may be understood in accordance with the following description taken in conjunction with the accompanying drawings as follows:

FIG. **1** is a perspective view of a powered surgical stapling system;

FIG. **2** is a perspective view of an interchangeable surgical shaft assembly of the powered surgical stapling system of FIG. **1**;

FIG. **3** is an exploded assembly view of portions of a handle assembly of the powered surgical stapling system of FIG. **1**;

FIG. **4** is an exploded assembly view of the interchangeable surgical shaft assembly of FIG. **2**;

FIG. **5** is another partial exploded assembly view of a portion of the interchangeable surgical shaft assembly of FIG. **4**;

FIG. **6** is another partial perspective view of an end effector portion of the interchangeable surgical shaft assembly of FIG. **2** with jaws thereof in an open position;

FIG. **7** is another perspective view of a portion of the end effector and interchangeable shaft assembly of FIG. **6**;

FIG. **8** is a perspective view of a distal closure member embodiment;

FIG. **9** is an end view of the distal closure member embodiment of FIG. **8**;

FIG. **10** is a side elevational view of the end effector and portion of interchangeable surgical shaft assembly of FIG. **7**, with an anvil and a closure member thereof in a fully open position;

FIG. **11** is a cross-sectional view of the end effector and closure member of FIG. **10**, taken along line **11-11** in FIG. **10**;

FIG. **12** is a side elevational view of the end effector and portion of interchangeable surgical shaft assembly of FIG. **11**, with the anvil and closure member in a closed position;

FIG. **13** is a cross-sectional view of the anvil and closure member of FIG. **12**, taken along line **13-13** in FIG. **12**;

FIG. **14** is a side elevational view of the end effector and portion of the interchangeable surgical tool assembly of FIG. **13**, with the anvil and closure member thereof in an "over-closed" position;

FIG. **15** is a cross-sectional view of the end effector and closure member of FIG. **14** taken along line **15-15** of FIG. **14**;

FIG. **16** is a perspective view of a portion of another end effector and interchangeable surgical shaft assembly, with an anvil thereof in an open position;

FIG. **17** is a side elevational view of the end effector and portion of interchangeable surgical shaft assembly of FIG. **16**, with the anvil and a closure member thereof in a fully open position;

FIG. **18** is a cross-sectional view of the end effector and closure member of FIG. **17**, taken along line **18-18** in FIG. **17**;

FIG. **19** is a side elevational view of the end effector and portion of interchangeable surgical shaft assembly of FIG. **17**, with the anvil and closure member thereof in a closed position;

FIG. **20** is a cross-sectional view of the end effector and closure member of FIG. **19**, taken along line **20-20** in FIG. **19**;

FIG. **21** is a side elevational view of the end effector and portion of interchangeable surgical shaft assembly of FIG. **19**, with the anvil and closure member thereof in an over-closed position;

FIG. **22** is a cross-sectional view of the end effector and closure member of FIG. **21**, taken along line **22-22** in FIG. **21**;

FIG. **23** is an end view of another distal closure member embodiment;

FIG. **24** is a side elevational view of another end effector and portion of another interchangeable surgical shaft assembly, with an anvil and a closure member thereof in an open position;

FIG. **25** is a cross-sectional view of the end effector and closure member of FIG. **24**, taken along line **25-25** in FIG. **24**;

FIG. **26** is a side elevational view of the end effector and interchangeable surgical shaft assembly of FIG. **24**, with the anvil and closure member thereof in a closed position;

FIG. **27** is a cross-sectional view of the end effector and closure member of FIG. **26**, taken along line **27-27** in FIG. **26**;

FIG. **28** is a side elevational view of the end effector and interchangeable surgical shaft assembly of FIG. **24**, with the anvil and closure member thereof in an over-closed position;

FIG. **29** is a cross-sectional view of the end effector and closure member of FIG. **28**, taken along line **29-29** in FIG. **28**;

FIG. **30** is an end view of another closure member embodiment;

FIG. **31** is a side elevational view of another end effector and portion of another interchangeable surgical shaft assembly, with an anvil and a closure member thereof in a closed position;

FIG. **32** is another side elevational view of the end effector of the interchangeable surgical shaft assembly of FIG. **31**, with the anvil and closure member thereof in an "over-closed' position;

FIG. **33** is an enlarged side elevational view of a portion of the end effector and closure member of FIG. **31**, with the anvil in the closed position;

FIG. **34** is another enlarged side elevational view of a portion of the end effector and closure member of FIG. **32**, with the anvil in the over-closed position;

FIG. **35** is a side elevational view of another end effector and portion of another interchangeable surgical shaft assembly, with an anvil and a closure member thereof in a closed position;

FIG. **36** is an enlarged side elevational view of a portion of the end effector and closure member of FIG. **35**, with the anvil in the closed position;

FIG. **37** is another side elevational view of the end effector of the interchangeable surgical shaft assembly of FIG. **35**, with the anvil and closure member thereof in an over-closed position;

FIG. **38** is another enlarged side elevational view of a portion of the end effector and closure member of FIG. **37**, with the anvil in the over-closed position;

FIG. **39** is a perspective view of a previous surgical staple cartridge configured to form flexible lines of surgical staples;

FIG. **40** is a top view of lines of surgical staples formed in tissue by the surgical staple cartridge of FIG. **39**;

FIG. **41** is a side elevational view of a previous surgical staple embodiment; and

FIG. **42** is a side elevational view of another previous surgical staple embodiment.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate various embodiments of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

Applicant of the present application owns the following U.S. Patent Applications that were filed Aug. 20, 2018 and which are each herein incorporated by reference in their respective entireties:

- U.S. patent application Ser. No. 16/105,101, entitled METHOD FOR FABRICATING SURGICAL STAPLER ANVILS, now U.S. Patent Application Publication No. 2020/0054323;
- U.S. patent application Ser. No. 16/105,183, entitled REINFORCED DEFORMABLE ANVIL TIP FOR SURGICAL STAPLER ANVIL, now U.S. Patent Application Publication No. 2020/0054327;
- U.S. patent application Ser. No. 16/105,150, entitled SURGICAL STAPLER ANVILS WITH STAPLE DIRECTING PROTRUSIONS AND TISSUE STABILITY FEATURES, now U.S. Patent Application Publication No. 2020/0054326;
- U.S. patent application Ser. No. 16/105,098, entitled FABRICATING TECHNIQUES FOR SURGICAL STAPLER ANVILS, now U.S. Patent Application Publication No. 2020/0054322;
- U.S. patent application Ser. No. 16/105,122, entitled SURGICAL STAPLING DEVICES WITH IMPROVED CLOSURE MEMBERS, now U.S. Patent Application Publication No. 2020/0054324;
- U.S. patent application Ser. No. 16/105,081, entitled METHOD FOR OPERATING A POWERED ARTICULATABLE SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2020/0054320;
- U.S. patent application Ser. No. 16/105,094, entitled SURGICAL INSTRUMENTS WITH PROGRESSIVE JAW CLOSURE ARRANGEMENTS, now U.S. Patent Application Publication No. 2020/0054321;
- U.S. patent application Ser. No. 16/105,097, entitled POWERED SURGICAL INSTRUMENTS WITH CLUTCHING ARRANGEMENTS TO CONVERT LINEAR DRIVE MOTIONS TO ROTARY DRIVE MOTIONS, now U.S. Patent Application Publication No. 2020/0054328;
- U.S. patent application Ser. No. 16/105,104, entitled POWERED ARTICULATABLE SURGICAL INSTRUMENTS WITH CLUTCHING AND LOCKING ARRANGEMENTS FOR LINKING AN ARTICULATION DRIVE SYSTEM TO A FIRING DRIVE SYSTEM, now U.S. Patent Application Publication No. 2020/0054329;
- U.S. patent application Ser. No. 16/105,119, entitled ARTICULATABLE MOTOR POWERED SURGICAL INSTRUMENTS WITH DEDICATED ARTICULATION MOTOR ARRANGEMENTS, now U.S. Patent Application Publication No. 2020/0054330;
- U.S. patent application Ser. No. 16/105,160, entitled SWITCHING ARRANGEMENTS FOR MOTOR POWERED ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2020/0054331; and
- U.S. Design patent application Ser. No. 29/660,252, entitled SURGICAL STAPLER ANVIL.

Applicant of the present application owns the following U.S. Patent Applications and U.S. Patents that are each herein incorporated by reference in their respective entireties:

- U.S. patent application Ser. No. 15/386,185, entitled SURGICAL STAPLING INSTRUMENTS AND REPLACEABLE TOOL ASSEMBLIES THEREOF, U.S. Patent Application Publication No. 2018-0168642;
- U.S. patent application Ser. No. 15/386,230, entitled ARTICULATABLE SURGICAL STAPLING INSTRUMENTS, U.S. Patent Application Publication No. 2018-0168649;
- U.S. patent application Ser. No. 15/386,221, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS, U.S. Patent Application Publication No. 2018-01686;
- U.S. patent application Ser. No. 15/386,209, entitled SURGICAL END EFFECTORS AND FIRING MEMBERS THEREOF, U.S. Patent Application Publication No. 2018-0168645;
- U.S. patent application Ser. No. 15/386,198, entitled LOCKOUT ARRANGEMENTS FOR SURGICAL END EFFECTORS AND REPLACEABLE TOOL ASSEMBLIES, U.S. Patent Application Publication No. 2018-0168644;
- U.S. patent application Ser. No. 15/386,240, entitled SURGICAL END EFFECTORS AND ADAPTABLE FIRING MEMBERS THEREFOR, U.S. Patent Application Publication No. 2018-0168651.
- U.S. patent application Ser. No. 15/385,939, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, U.S. Patent Application Publication No. 2018-0168629;
- U.S. patent application Ser. No. 15/385,941, entitled SURGICAL TOOL ASSEMBLIES WITH CLUTCHING ARRANGEMENTS FOR SHIFTING BETWEEN CLOSURE SYSTEMS WITH CLOSURE STROKE REDUCTION FEATURES AND ARTICULATION AND FIRING SYSTEMS, U.S. Patent Application Publication No. 2018-0168630;
- U.S. patent application Ser. No. 15/385,943, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, U.S. Patent Application Publication No. 2018-0168631;
- U.S. patent application Ser. No. 15/385,950, entitled SURGICAL TOOL ASSEMBLIES WITH CLOSURE STROKE REDUCTION FEATURES, U.S. Patent Application Publication No. 2018-0168635;
- U.S. patent application Ser. No. 15/385,945, entitled STAPLE CARTRIDGES AND ARRANGEMENTS

OF STAPLES AND STAPLE CAVITIES THEREIN; U.S. Patent Application Publication No. 2018-0168632;

U.S. patent application Ser. No. 15/385,946, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, U.S. Patent Application Publication No. 2018-0168633;

U.S. patent application Ser. No. 15/385,951, entitled SURGICAL INSTRUMENTS WITH JAW OPENING FEATURES FOR INCREASING A JAW OPENING DISTANCE, U.S. Patent Application Publication No. 2018-0168636;

U.S. patent application Ser. No. 15/385,953, entitled METHODS OF STAPLING TISSUE, U.S. Patent Application Publication No. 2018-0168637;

U.S. patent application Ser. No. 15/385,954, entitled FIRING MEMBERS WITH NON-PARALLEL JAW ENGAGEMENT FEATURES FOR SURGICAL END EFFECTORS, U.S. Patent Application Publication No. 2018-0168638;

U.S. patent application Ser. No. 15/385,955, entitled SURGICAL END EFFECTORS WITH EXPANDABLE TISSUE STOP ARRANGEMENTS, U.S. Patent Application Publication No. 2018-0168639;

U.S. patent application Ser. No. 15/385,948, entitled SURGICAL STAPLING INSTRUMENTS AND STAPLE-FORMING ANVILS, U.S. Patent Application Publication No. 2018-0168584;

U.S. patent application Ser. No. 15/385,956, entitled SURGICAL INSTRUMENTS WITH POSITIVE JAW OPENING FEATURES, U.S. Patent Application Publication No. 2018-0168640;

U.S. patent application Ser. No. 15/385,958, entitled SURGICAL INSTRUMENTS WITH LOCKOUT ARRANGEMENTS FOR PREVENTING FIRING SYSTEM ACTUATION UNLESS AN UNSPENT STAPLE CARTRIDGE IS PRESENT, U.S. Patent Application Publication No. 2018-0168641;

U.S. patent application Ser. No. 15/385,947, entitled STAPLE CARTRIDGES AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, U.S. Patent Application Publication No. 2018-0168634;

U.S. patent application Ser. No. 15/385,896, entitled METHOD FOR RESETTING A FUSE OF A SURGICAL INSTRUMENT SHAFT, U.S. Patent Application Publication No. 2018-0168597;

U.S. patent application Ser. No. 15/385,898, entitled STAPLE-FORMING POCKET ARRANGEMENT TO ACCOMMODATE DIFFERENT TYPES OF STAPLES, U.S. Patent Application Publication No. 2018-0168599;

U.S. patent application Ser. No. 15/385,899, entitled SURGICAL INSTRUMENT COMPRISING IMPROVED JAW CONTROL, U.S. Patent Application Publication No. 2018-0168600;

U.S. patent application Ser. No. 15/385,901, entitled STAPLE CARTRIDGE AND STAPLE CARTRIDGE CHANNEL COMPRISING WINDOWS DEFINED THEREIN, U.S. Patent Application Publication No. 2018-0168602;

U.S. patent application Ser. No. 15/385,902, entitled SURGICAL INSTRUMENT COMPRISING A CUTTING MEMBER, U.S. Patent Application Publication No. 2018-0168603;

U.S. patent application Ser. No. 15/385,904, entitled STAPLE FIRING MEMBER COMPRISING A MISSING CARTRIDGE AND/OR SPENT CARTRIDGE LOCKOUT, U.S. Patent Application Publication No. 2018-0168605;

U.S. patent application Ser. No. 15/385,905, entitled FIRING ASSEMBLY COMPRISING A LOCKOUT, U.S. Patent Application Publication No. 2018-0168606;

U.S. patent application Ser. No. 15/385,907, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING AN END EFFECTOR LOCKOUT AND A FIRING ASSEMBLY LOCKOUT, U.S. Patent Application Publication No. 2018-0168608;

U.S. patent application Ser. No. 15/385,908, entitled FIRING ASSEMBLY COMPRISING A FUSE, U.S. Patent Application Publication No. 2018-0168609;

U.S. patent application Ser. No. 15/385,909, entitled FIRING ASSEMBLY COMPRISING A MULTIPLE FAILED-STATE FUSE, U.S. Patent Application Publication No. 2018-0168610;

U.S. patent application Ser. No. 15/385,920, entitled STAPLE-FORMING POCKET ARRANGEMENTS, U.S. Patent Application Publication No. 2018-0168620;

U.S. patent application Ser. No. 15/385,913, entitled ANVIL ARRANGEMENTS FOR SURGICAL STAPLERS, U.S. Patent Application Publication No. 2018-0168614;

U.S. patent application Ser. No. 15/385,914, entitled METHOD OF DEFORMING STAPLES FROM TWO DIFFERENT TYPES OF STAPLE CARTRIDGES WITH THE SAME SURGICAL STAPLING INSTRUMENT, U.S. Patent Application Publication No. 2018-0168615;

U.S. patent application Ser. No. 15/385,893, entitled BILATERALLY ASYMMETRIC STAPLE-FORMING POCKET PAIRS, U.S. Patent Application Publication No. 2018-0168594;

U.S. patent application Ser. No. 15/385,929, entitled CLOSURE MEMBERS WITH CAM SURFACE ARRANGEMENTS FOR SURGICAL INSTRUMENTS WITH SEPARATE AND DISTINCT CLOSURE AND FIRING SYSTEMS, U.S. Patent Application Publication No. 2018-0168626;

U.S. patent application Ser. No. 15/385,911, entitled SURGICAL STAPLERS WITH INDEPENDENTLY ACTUATABLE CLOSING AND FIRING SYSTEMS, U.S. Patent Application Publication No. 2018-0168612;

U.S. patent application Ser. No. 15/385,927, entitled SURGICAL STAPLING INSTRUMENTS WITH SMART STAPLE CARTRIDGES, U.S. Patent Application Publication No. 2018-0168625;

U.S. patent application Ser. No. 15/385,917, entitled STAPLE CARTRIDGE COMPRISING STAPLES WITH DIFFERENT CLAMPING BREADTHS, U.S. Patent Application Publication No. 2018-0168617;

U.S. patent application Ser. No. 15/385,900, entitled STAPLE-FORMING POCKET ARRANGEMENTS COMPRISING PRIMARY SIDEWALLS AND POCKET SIDEWALLS, U.S. Patent Application Publication No. 2018-0168601;

U.S. patent application Ser. No. 15/385,931, entitled NO-CARTRIDGE AND SPENT CARTRIDGE LOCKOUT ARRANGEMENTS FOR SURGICAL STAPLERS, U.S. Patent Application Publication No. 2018-0168627;

U.S. patent application Ser. No. 15/385,915, entitled FIRING MEMBER PIN ANGLE, U.S. Patent Application Publication No. 2018-0168616;

U.S. patent application Ser. No. 15/385,897, entitled STAPLE-FORMING POCKET ARRANGEMENTS COMPRISING ZONED FORMING SURFACE GROOVES, U.S. Patent Application Publication No. 2018-0168598;

U.S. patent application Ser. No. 15/385,922, entitled SURGICAL INSTRUMENT WITH MULTIPLE FAILURE RESPONSE MODES, U.S. Patent Application Publication No. 2018-0168622;

U.S. patent application Ser. No. 15/385,924, entitled SURGICAL INSTRUMENT WITH PRIMARY AND SAFETY PROCESSORS, U.S. Patent Application Publication No. 2018-0168624;

U.S. patent application Ser. No. 15/385,910, entitled ANVIL HAVING A KNIFE SLOT WIDTH, U.S. Patent Application Publication No. 2018-0168611;

U.S. patent application Ser. No. 15/385,903, entitled CLOSURE MEMBER ARRANGEMENTS FOR SURGICAL INSTRUMENTS, U.S. Patent Application Publication No. 2018-0168604;

U.S. patent application Ser. No. 15/385,906, entitled FIRING MEMBER PIN CONFIGURATIONS, U.S. Patent Application Publication No. 2018-0168607;

U.S. patent application Ser. No. 15/386,188, entitled STEPPED STAPLE CARTRIDGE WITH ASYMMETRICAL STAPLES, U.S. Patent Application Publication No. 2018-0168585;

U.S. patent application Ser. No. 15/386,192, entitled STEPPED STAPLE CARTRIDGE WITH TISSUE RETENTION AND GAP SETTING FEATURES, U.S. Patent Application Publication No. 2018-0168643;

U.S. patent application Ser. No. 15/386,206, entitled STAPLE CARTRIDGE WITH DEFORMABLE DRIVER RETENTION FEATURES, U.S. Patent Application Publication No. 2018-0168586;

U.S. patent application Ser. No. 15/386,226, entitled DURABILITY FEATURES FOR END EFFECTORS AND FIRING ASSEMBLIES OF SURGICAL STAPLING INSTRUMENTS, U.S. Patent Application Publication No. 2018-0168648;

U.S. patent application Ser. No. 15/386,222, entitled SURGICAL STAPLING INSTRUMENTS HAVING END EFFECTORS WITH POSITIVE OPENING FEATURES, U.S. Patent Application Publication No. 2018-0168647;

U.S. patent application Ser. No. 15/386,236, entitled CONNECTION PORTIONS FOR DEPOSABLE LOADING UNITS FOR SURGICAL STAPLING INSTRUMENTS, U.S. Patent Application Publication No. 2018-0168650;

U.S. patent application Ser. No. 15/385,887, entitled METHOD FOR ATTACHING A SHAFT ASSEMBLY TO A SURGICAL INSTRUMENT AND, ALTERNATIVELY, TO A SURGICAL ROBOT, U.S. Patent Application Publication No. 2018-0168589;

U.S. patent application Ser. No. 15/385,889, entitled SHAFT ASSEMBLY COMPRISING A MANUALLY-OPERABLE RETRACTION SYSTEM FOR USE WITH A MOTORIZED SURGICAL INSTRUMENT SYSTEM, U.S. Patent Application Publication No. 2018-0168590;

U.S. patent application Ser. No. 15/385,890, entitled SHAFT ASSEMBLY COMPRISING SEPARATELY ACTUATABLE AND RETRACTABLE SYSTEMS, U.S. Patent Application Publication No. 2018-0168591;

U.S. patent application Ser. No. 15/385,891, entitled SHAFT ASSEMBLY COMPRISING A CLUTCH CONFIGURED TO ADAPT THE OUTPUT OF A ROTARY FIRING MEMBER TO TWO DIFFERENT SYSTEMS, U.S. Patent Application Publication No. 2018-0168592;

U.S. patent application Ser. No. 15/385,892, entitled SURGICAL SYSTEM COMPRISING A FIRING MEMBER ROTATABLE INTO AN ARTICULATION STATE TO ARTICULATE AN END EFFECTOR OF THE SURGICAL SYSTEM, U.S. Patent Application Publication No. 2018-0168593;

U.S. patent application Ser. No. 15/385,894, entitled SHAFT ASSEMBLY COMPRISING A LOCKOUT, U.S. Patent Application Publication No. 2018-0168595;

U.S. patent application Ser. No. 15/385,895, entitled SHAFT ASSEMBLY COMPRISING FIRST AND SECOND ARTICULATION LOCKOUTS, U.S. Patent Application Publication No. 2018-0168596;

U.S. patent application Ser. No. 15/385,916, entitled SURGICAL STAPLING SYSTEMS, U.S. Patent Application Publication No. 2018-0168575;

U.S. patent application Ser. No. 15/385,918, entitled SURGICAL STAPLING SYSTEMS, U.S. Patent Application Publication No. 2018-0168618;

U.S. patent application Ser. No. 15/385,919, entitled SURGICAL STAPLING SYSTEMS, U.S. Patent Application Publication No. 2018-0168619;

U.S. patent application Ser. No. 15/385,921, entitled SURGICAL STAPLE CARTRIDGE WITH MOVABLE CAMMING MEMBER CONFIGURED TO DISENGAGE FIRING MEMBER LOCKOUT FEATURES, U.S. Patent Application Publication No. 2018-0168621;

U.S. patent application Ser. No. 15/385,923, entitled SURGICAL STAPLING SYSTEMS, U.S. Patent Application Publication No. 2018-0168623;

U.S. patent application Ser. No. 15/385,925, entitled JAW ACTUATED LOCK ARRANGEMENTS FOR PREVENTING ADVANCEMENT OF A FIRING MEMBER IN A SURGICAL END EFFECTOR UNLESS AN UNFIRED CARTRIDGE IS INSTALLED IN THE END EFFECTOR, U.S. Patent Application Publication No. 2018-0168576;

U.S. patent application Ser. No. 15/385,926, entitled AXIALLY MOVABLE CLOSURE SYSTEM ARRANGEMENTS FOR APPLYING CLOSURE MOTIONS TO JAWS OF SURGICAL INSTRUMENTS, U.S. Patent Application Publication No. 2018-0168577;

U.S. patent application Ser. No. 15/385,928, entitled PROTECTIVE COVER ARRANGEMENTS FOR A JOINT INTERFACE BETWEEN A MOVABLE JAW AND ACTUATOR SHAFT OF A SURGICAL INSTRUMENT, U.S. Patent Application Publication No. 2018-0168578;

U.S. patent application Ser. No. 15/385,930, entitled SURGICAL END EFFECTOR WITH TWO SEPARATE COOPERATING OPENING FEATURES FOR OPENING AND CLOSING END EFFECTOR JAWS, U.S. Patent Application Publication No. 2018-0168579;

U.S. patent application Ser. No. 15/385,932, entitled ARTICULATABLE SURGICAL END EFFECTOR WITH ASYMMETRIC SHAFT ARRANGEMENT, U.S. Patent Application Publication No. 2018-0168628;

U.S. patent application Ser. No. 15/385,933, entitled ARTICULATABLE SURGICAL INSTRUMENT WITH INDEPENDENT PIVOTABLE LINKAGE DISTAL OF AN ARTICULATION LOCK, U.S. Patent Application Publication No. 2018-0168580;

U.S. patent application Ser. No. 15/385,934, entitled ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR IN AN ARTICULATED POSITION IN RESPONSE TO ACTUATION OF A JAW CLOSURE SYSTEM, U.S. Patent Application Publication No. 2018-0168581;

U.S. patent application Ser. No. 15/385,935, entitled LATERALLY ACTUATABLE ARTICULATION LOCK ARRANGEMENTS FOR LOCKING AN END EFFECTOR OF A SURGICAL INSTRUMENT IN AN ARTICULATED CONFIGURATION, U.S. Patent Application Publication No. 2018-0168582;

U.S. patent application Ser. No. 15/385,936, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH ARTICULATION STROKE AMPLIFICATION FEATURES, U.S. Patent Application Publication No., U.S. Patent Application Publication No. 2018-0168583;

U.S. patent application Ser. No. 14/318,996, entitled FASTENER CARTRIDGES INCLUDING EXTENSIONS HAVING DIFFERENT CONFIGURATIONS, U.S. Patent Application Publication No. 2015-0297228;

U.S. patent application Ser. No. 14/319,006, entitled FASTENER CARTRIDGE COMPRISING FASTENER CAVITIES INCLUDING FASTENER CONTROL FEATURES, Now U.S. Pat. No. 10,010,324;

U.S. patent application Ser. No. 14/318,991, entitled SURGICAL FASTENER CARTRIDGES WITH DRIVER STABILIZING ARRANGEMENTS, now U.S. Pat. No. 9,833,241;

U.S. patent application Ser. No. 14/319,004, entitled SURGICAL END EFFECTORS WITH FIRING ELEMENT MONITORING ARRANGEMENTS, now U.S. Pat. No. 9,844,369;

U.S. patent application Ser. No. 14/319,008, entitled FASTENER CARTRIDGE COMPRISING NON-UNIFORM FASTENERS, U.S. Patent Application Publication No. 2015-0297232;

U.S. patent application Ser. No. 14/318,997, entitled FASTENER CARTRIDGE COMPRISING DEPLOYABLE TISSUE ENGAGING MEMBERS, U.S. Patent Application Publication No. 2015-0297229;

U.S. patent application Ser. No. 14/319,002, entitled FASTENER CARTRIDGE COMPRISING TISSUE CONTROL FEATURES, now U.S. Pat. No. 9,877,721;

U.S. patent application Ser. No. 14/319,013, entitled FASTENER CARTRIDGE ASSEMBLIES AND STAPLE RETAINER COVER ARRANGEMENTS, U.S. Patent Application Publication No. 2015-0297233; and

U.S. patent application Ser. No. 14/319,016, entitled FASTENER CARTRIDGE INCLUDING A LAYER ATTACHED THERETO, U.S. Patent Application Publication No. 2015-0297235.

Applicant of the present application owns the following U.S. Patent Applications that were filed on Jun. 24, 2016 and which are each herein incorporated by reference in their respective entireties:

U.S. patent application Ser. No. 15/191,775, entitled STAPLE CARTRIDGE COMPRISING WIRE STAPLES AND STAMPED STAPLES;

U.S. patent application Ser. No. 15/191,807, entitled STAPLING SYSTEM FOR USE WITH WIRE STAPLES AND STAMPED STAPLES;

U.S. patent application Ser. No. 15/191,834, entitled STAMPED STAPLES AND STAPLE CARTRIDGES USING THE SAME;

U.S. patent application Ser. No. 15/191,788, entitled STAPLE CARTRIDGE COMPRISING OVER-DRIVEN STAPLES; and

U.S. patent application Ser. No. 15/191,818, entitled STAPLE CARTRIDGE COMPRISING OFFSET LONGITUDINAL STAPLE ROWS.

Applicant of the present application owns the following U.S. Patent Applications that were filed on Jun. 24, 2016 and which are each herein incorporated by reference in their respective entireties:

U.S. Design patent application Ser. No. 29/569,218, entitled SURGICAL FASTENER;

U.S. Design patent application Ser. No. 29/569,227, entitled SURGICAL FASTENER;

U.S. Design patent application Ser. No. 29/569,259, entitled SURGICAL FASTENER CARTRIDGE; and

U.S. Design patent application Ser. No. 29/569,264, entitled SURGICAL FASTENER CARTRIDGE.

Applicant of the present application owns the following patent applications that were filed on Apr. 1, 2016 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 15/089,325, entitled METHOD FOR OPERATING A SURGICAL STAPLING SYSTEM;

U.S. patent application Ser. No. 15/089,321, entitled MODULAR SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY;

U.S. patent application Ser. No. 15/089,326, entitled SURGICAL STAPLING SYSTEM COMPRISING A DISPLAY INCLUDING A RE-ORIENTABLE DISPLAY FIELD;

U.S. patent application Ser. No. 15/089,263, entitled SURGICAL INSTRUMENT HANDLE ASSEMBLY WITH RECONFIGURABLE GRIP PORTION;

U.S. patent application Ser. No. 15/089,262, entitled ROTARY POWERED SURGICAL INSTRUMENT WITH MANUALLY ACTUATABLE BAILOUT SYSTEM;

U.S. patent application Ser. No. 15/089,277, entitled SURGICAL CUTTING AND STAPLING END EFFECTOR WITH ANVIL CONCENTRIC DRIVE MEMBER;

U.S. patent application Ser. No. 15/089,296, entitled INTERCHANGEABLE SURGICAL TOOL ASSEMBLY WITH A SURGICAL END EFFECTOR THAT IS SELECTIVELY ROTATABLE ABOUT A SHAFT AXIS;

U.S. patent application Ser. No. 15/089,258, entitled SURGICAL STAPLING SYSTEM COMPRISING A SHIFTABLE TRANSMISSION;

U.S. patent application Ser. No. 15/089,278, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO PROVIDE SELECTIVE CUTTING OF TISSUE;

U.S. patent application Ser. No. 15/089,284, entitled SURGICAL STAPLING SYSTEM COMPRISING A CONTOURABLE SHAFT;

U.S. patent application Ser. No. 15/089,295, entitled SURGICAL STAPLING SYSTEM COMPRISING A TISSUE COMPRESSION LOCKOUT;

U.S. patent application Ser. No. 15/089,300, entitled SURGICAL STAPLING SYSTEM COMPRISING AN UNCLAMPING LOCKOUT;

U.S. patent application Ser. No. 15/089,196, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW CLOSURE LOCKOUT;

U.S. patent application Ser. No. 15/089,203, entitled SURGICAL STAPLING SYSTEM COMPRISING A JAW ATTACHMENT LOCKOUT;

U.S. patent application Ser. No. 15/089,210, entitled SURGICAL STAPLING SYSTEM COMPRISING A SPENT CARTRIDGE LOCKOUT;

U.S. patent application Ser. No. 15/089,324, entitled SURGICAL INSTRUMENT COMPRISING A SHIFTING MECHANISM;

U.S. patent application Ser. No. 15/089,335, entitled SURGICAL STAPLING INSTRUMENT COMPRISING MULTIPLE LOCKOUTS;

U.S. patent application Ser. No. 15/089,339, entitled SURGICAL STAPLING INSTRUMENT;

U.S. patent application Ser. No. 15/089,253, entitled SURGICAL STAPLING SYSTEM CONFIGURED TO APPLY ANNULAR ROWS OF STAPLES HAVING DIFFERENT HEIGHTS;

U.S. patent application Ser. No. 15/089,304, entitled SURGICAL STAPLING SYSTEM COMPRISING A GROOVED FORMING POCKET;

U.S. patent application Ser. No. 15/089,331, entitled ANVIL MODIFICATION MEMBERS FOR SURGICAL STAPLERS;

U.S. patent application Ser. No. 15/089,336, entitled STAPLE CARTRIDGES WITH ATRAUMATIC FEATURES;

U.S. patent application Ser. No. 15/089,312, entitled CIRCULAR STAPLING SYSTEM COMPRISING AN INCISABLE TISSUE SUPPORT;

U.S. patent application Ser. No. 15/089,309, entitled CIRCULAR STAPLING SYSTEM COMPRISING ROTARY FIRING SYSTEM; and

U.S. patent application Ser. No. 15/089,349, entitled CIRCULAR STAPLING SYSTEM COMPRISING LOAD CONTROL.

Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Dec. 31, 2015 which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/984,488, entitled MECHANISMS FOR COMPENSATING FOR BATTERY PACK FAILURE IN POWERED SURGICAL INSTRUMENTS;

U.S. patent application Ser. No. 14/984,525, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS; and

U.S. patent application Ser. No. 14/984,552, entitled SURGICAL INSTRUMENTS WITH SEPARABLE MOTORS AND MOTOR CONTROL CIRCUITS.

Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Feb. 9, 2016 which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 15/019,220, entitled SURGICAL INSTRUMENT WITH ARTICULATING AND AXIALLY TRANSLATABLE END EFFECTOR;

U.S. patent application Ser. No. 15/019,228, entitled SURGICAL INSTRUMENTS WITH MULTIPLE LINK ARTICULATION ARRANGEMENTS;

U.S. patent application Ser. No. 15/019,196, entitled SURGICAL INSTRUMENT ARTICULATION MECHANISM WITH SLOTTED SECONDARY CONSTRAINT;

U.S. patent application Ser. No. 15/019,206, entitled SURGICAL INSTRUMENTS WITH AN END EFFECTOR THAT IS HIGHLY ARTICULATABLE RELATIVE TO AN ELONGATE SHAFT ASSEMBLY;

U.S. patent application Ser. No. 15/019,215, entitled SURGICAL INSTRUMENTS WITH NON-SYMMETRICAL ARTICULATION ARRANGEMENTS;

U.S. patent application Ser. No. 15/019,227, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH SINGLE ARTICULATION LINK ARRANGEMENTS;

U.S. patent application Ser. No. 15/019,235, entitled SURGICAL INSTRUMENTS WITH TENSIONING ARRANGEMENTS FOR CABLE DRIVEN ARTICULATION SYSTEMS;

U.S. patent application Ser. No. 15/019,230, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH OFF-AXIS FIRING BEAM ARRANGEMENTS; and

U.S. patent application Ser. No. 15/019,245, entitled SURGICAL INSTRUMENTS WITH CLOSURE STROKE REDUCTION ARRANGEMENTS.

Applicant of the present application also owns the U.S. Patent Applications identified below which were filed on Feb. 12, 2016 which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 15/043,254, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS;

U.S. patent application Ser. No. 15/043,259, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS;

U.S. patent application Ser. No. 15/043,275, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS; and

U.S. patent application Ser. No. 15/043,289, entitled MECHANISMS FOR COMPENSATING FOR DRIVETRAIN FAILURE IN POWERED SURGICAL INSTRUMENTS.

Applicant of the present application owns the following patent applications that were filed on Jun. 18, 2015 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/742,925, entitled SURGICAL END EFFECTORS WITH POSITIVE JAW OPENING ARRANGEMENTS;

U.S. patent application Ser. No. 14/742,941, entitled SURGICAL END EFFECTORS WITH DUAL CAM ACTUATED JAW CLOSING FEATURES;

U.S. patent application Ser. No. 14/742,914, entitled MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS;

U.S. patent application Ser. No. 14/742,900, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH COMPOSITE FIRING BEAM STRUCTURES WITH CENTER FIRING SUPPORT MEMBER FOR ARTICULATION SUPPORT;

U.S. patent application Ser. No. 14/742,885, entitled DUAL ARTICULATION DRIVE SYSTEM ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS; and

U.S. patent application Ser. No. 14/742,876, entitled PUSH/PULL ARTICULATION DRIVE SYSTEMS FOR ARTICULATABLE SURGICAL INSTRUMENTS.

Applicant of the present application owns the following patent applications that were filed on Mar. 6, 2015 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/640,746, entitled POWERED SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0256184;

U.S. patent application Ser. No. 14/640,795, entitled MULTIPLE LEVEL THRESHOLDS TO MODIFY OPERATION OF POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/02561185;

U.S. patent application Ser. No. 14/640,832, entitled ADAPTIVE TISSUE COMPRESSION TECHNIQUES TO ADJUST CLOSURE RATES FOR MULTIPLE TISSUE TYPES, now U.S. Patent Application Publication No. 2016/0256154;

U.S. patent application Ser. No. 14/640,935, entitled OVERLAID MULTI SENSOR RADIO FREQUENCY (RF) ELECTRODE SYSTEM TO MEASURE TISSUE COMPRESSION, now U.S. Patent Application Publication No. 2016/0256071;

U.S. patent application Ser. No. 14/640,831, entitled MONITORING SPEED CONTROL AND PRECISION INCREMENTING OF MOTOR FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0256153;

U.S. patent application Ser. No. 14/640,859, entitled TIME DEPENDENT EVALUATION OF SENSOR DATA TO DETERMINE STABILITY, CREEP, AND VISCOELASTIC ELEMENTS OF MEASURES, now U.S. Patent Application Publication No. 2016/0256187;

U.S. patent application Ser. No. 14/640,817, entitled INTERACTIVE FEEDBACK SYSTEM FOR POWERED SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0256186;

U.S. patent application Ser. No. 14/640,844, entitled CONTROL TECHNIQUES AND SUB-PROCESSOR CONTAINED WITHIN MODULAR SHAFT WITH SELECT CONTROL PROCESSING FROM HANDLE, now U.S. Patent Application Publication No. 2016/0256155;

U.S. patent application Ser. No. 14/640,837, entitled SMART SENSORS WITH LOCAL SIGNAL PROCESSING, now U.S. Patent Application Publication No. 2016/0256163;

U.S. patent application Ser. No. 14/640,765, entitled SYSTEM FOR DETECTING THE MIS-INSERTION OF A STAPLE CARTRIDGE INTO A SURGICAL STAPLER, now U.S. Patent Application Publication No. 2016/0256160;

U.S. patent application Ser. No. 14/640,799, entitled SIGNAL AND POWER COMMUNICATION SYSTEM POSITIONED ON A ROTATABLE SHAFT, now U.S. Patent Application Publication No. 2016/0256162; and

U.S. patent application Ser. No. 14/640,780, entitled SURGICAL INSTRUMENT COMPRISING A LOCKABLE BATTERY HOUSING, now U.S. Patent Application Publication No. 2016/0256161.

Applicant of the present application owns the following patent applications that were filed on Feb. 27, 2015, and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/633,576, entitled SURGICAL INSTRUMENT SYSTEM COMPRISING AN INSPECTION STATION, now U.S. Patent Application Publication No. 2016/0249919;

U.S. patent application Ser. No. 14/633,546, entitled SURGICAL APPARATUS CONFIGURED TO ASSESS WHETHER A PERFORMANCE PARAMETER OF THE SURGICAL APPARATUS IS WITHIN AN ACCEPTABLE PERFORMANCE BAND, now U.S. Patent Application Publication No. 2016/0249915;

U.S. patent application Ser. No. 14/633,560, entitled SURGICAL CHARGING SYSTEM THAT CHARGES AND/OR CONDITIONS ONE OR MORE BATTERIES, now U.S. Patent Application Publication No. 2016/0249910;

U.S. patent application Ser. No. 14/633,566, entitled CHARGING SYSTEM THAT ENABLES EMERGENCY RESOLUTIONS FOR CHARGING A BATTERY, now U.S. Patent Application Publication No. 2016/0249918;

U.S. patent application Ser. No. 14/633,555, entitled SYSTEM FOR MONITORING WHETHER A SURGICAL INSTRUMENT NEEDS TO BE SERVICED, now U.S. Patent Application Publication No. 2016/0249916;

U.S. patent application Ser. No. 14/633,542, entitled REINFORCED BATTERY FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0249908;

U.S. patent application Ser. No. 14/633,548, entitled POWER ADAPTER FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2016/0249909;

U.S. patent application Ser. No. 14/633,526, entitled ADAPTABLE SURGICAL INSTRUMENT HANDLE, now U.S. Patent Application Publication No. 2016/0249945;

U.S. patent application Ser. No. 14/633,541, entitled MODULAR STAPLING ASSEMBLY, now U.S. Patent Application Publication No. 2016/0249927; and

U.S. patent application Ser. No. 14/633,562, entitled SURGICAL APPARATUS CONFIGURED TO TRACK AN END-OF-LIFE PARAMETER, now U.S. Patent Application Publication No. 2016/0249917.

Applicant of the present application owns the following patent applications that were filed on Dec. 18, 2014 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/574,478, entitled SURGICAL INSTRUMENT SYSTEMS COMPRIS-

ING AN ARTICULATABLE END EFFECTOR AND MEANS FOR ADJUSTING THE FIRING STROKE OF A FIRING MEMBER, now U.S. Patent Application Publication No. 2016/0174977;

U.S. patent application Ser. No. 14/574,483, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING LOCKABLE SYSTEMS, now U.S. Patent Application Publication No. 2016/0174969;

U.S. patent application Ser. No. 14/575,139, entitled DRIVE ARRANGEMENTS FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2016/0174978;

U.S. patent application Ser. No. 14/575,148, entitled LOCKING ARRANGEMENTS FOR DETACHABLE SHAFT ASSEMBLIES WITH ARTICULATABLE SURGICAL END EFFECTORS, now U.S. Patent Application Publication No. 2016/0174976;

U.S. patent application Ser. No. 14/575,130, entitled SURGICAL INSTRUMENT WITH AN ANVIL THAT IS SELECTIVELY MOVABLE ABOUT A DISCRETE NON-MOVABLE AXIS RELATIVE TO A STAPLE CARTRIDGE, now U.S. Patent Application Publication No. 2016/0174972;

U.S. patent application Ser. No. 14/575,143, entitled SURGICAL INSTRUMENTS WITH IMPROVED CLOSURE ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174983;

U.S. patent application Ser. No. 14/575,117, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND MOVABLE FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174975;

U.S. patent application Ser. No. 14/575,154, entitled SURGICAL INSTRUMENTS WITH ARTICULATABLE END EFFECTORS AND IMPROVED FIRING BEAM SUPPORT ARRANGEMENTS, now U.S. Patent Application Publication No. 2016/0174973;

U.S. patent application Ser. No. 14/574,493, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A FLEXIBLE ARTICULATION SYSTEM, now U.S. Patent Application Publication No. 2016/0174970; and

U.S. patent application Ser. No. 14/574,500, entitled SURGICAL INSTRUMENT ASSEMBLY COMPRISING A LOCKABLE ARTICULATION SYSTEM, now U.S. Patent Application Publication No. 2016/0174971.

Applicant of the present application owns the following patent applications that were filed on Mar. 1, 2013 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 13/782,295, entitled ARTICULATABLE SURGICAL INSTRUMENTS WITH CONDUCTIVE PATHWAYS FOR SIGNAL COMMUNICATION, now U.S. Patent Application Publication No. 2014/0246471;

U.S. patent application Ser. No. 13/782,323, entitled ROTARY POWERED ARTICULATION JOINTS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0246472;

U.S. patent application Ser. No. 13/782,338, entitled THUMBWHEEL SWITCH ARRANGEMENTS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0249557;

U.S. patent application Ser. No. 13/782,499, entitled ELECTROMECHANICAL SURGICAL DEVICE WITH SIGNAL RELAY ARRANGEMENT, now U.S. Pat. No. 9,358,003;

U.S. patent application Ser. No. 13/782,460, entitled MULTIPLE PROCESSOR MOTOR CONTROL FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0246478;

U.S. patent application Ser. No. 13/782,358, entitled JOYSTICK SWITCH ASSEMBLIES FOR SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,326,767;

U.S. patent application Ser. No. 13/782,481, entitled SENSOR STRAIGHTENED END EFFECTOR DURING REMOVAL THROUGH TROCAR, now U.S. Pat. No. 9,468,438;

U.S. patent application Ser. No. 13/782,518, entitled CONTROL METHODS FOR SURGICAL INSTRUMENTS WITH REMOVABLE IMPLEMENT PORTIONS, now U.S. Patent Application Publication No. 2014/0246475;

U.S. patent application Ser. No. 13/782,375, entitled ROTARY POWERED SURGICAL INSTRUMENTS WITH MULTIPLE DEGREES OF FREEDOM, now U.S. Pat. No. 9,398,911; and

U.S. patent application Ser. No. 13/782,536, entitled SURGICAL INSTRUMENT SOFT STOP, now U.S. Pat. No. 9,307,986.

Applicant of the present application also owns the following patent applications that were filed on Mar. 14, 2013 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 13/803,097, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, now U.S. Patent Application Publication No. 2014/0263542;

U.S. patent application Ser. No. 13/803,193, entitled CONTROL ARRANGEMENTS FOR A DRIVE MEMBER OF A SURGICAL INSTRUMENT, now U.S. Pat. No. 9,332,987;

U.S. patent application Ser. No. 13/803,053, entitled INTERCHANGEABLE SHAFT ASSEMBLIES FOR USE WITH A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0263564;

U.S. patent application Ser. No. 13/803,086, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK, now U.S. Patent Application Publication No. 2014/0263541;

U.S. patent application Ser. No. 13/803,210, entitled SENSOR ARRANGEMENTS FOR ABSOLUTE POSITIONING SYSTEM FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263538;

U.S. patent application Ser. No. 13/803,148, entitled MULTI-FUNCTION MOTOR FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0263554;

U.S. patent application Ser. No. 13/803,066, entitled DRIVE SYSTEM LOCKOUT ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263565;

U.S. patent application Ser. No. 13/803,117, entitled ARTICULATION CONTROL SYSTEM FOR ARTICULATABLE SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,351,726;

U.S. patent application Ser. No. 13/803,130, entitled DRIVE TRAIN CONTROL ARRANGEMENTS FOR MODULAR SURGICAL INSTRUMENTS, now U.S. Pat. No. 9,351,727; and

U.S. patent application Ser. No. 13/803,159, entitled METHOD AND SYSTEM FOR OPERATING A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0277017.

Applicant of the present application also owns the following patent application that was filed on Mar. 7, 2014 and is herein incorporated by reference in its entirety:

U.S. patent application Ser. No. 14/200,111, entitled CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2014/0263539.

Applicant of the present application also owns the following patent applications that were filed on Mar. 26, 2014 and are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/226,106, entitled POWER MANAGEMENT CONTROL SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272582;

U.S. patent application Ser. No. 14/226,099, entitled STERILIZATION VERIFICATION CIRCUIT, now U.S. Patent Application Publication No. 2015/0272581;

U.S. patent application Ser. No. 14/226,094, entitled VERIFICATION OF NUMBER OF BATTERY EXCHANGES/PROCEDURE COUNT, now U.S. Patent Application Publication No. 2015/0272580;

U.S. patent application Ser. No. 14/226,117, entitled POWER MANAGEMENT THROUGH SLEEP OPTIONS OF SEGMENTED CIRCUIT AND WAKE UP CONTROL, now U.S. Patent Application Publication No. 2015/0272574;

U.S. patent application Ser. No. 14/226,075, entitled MODULAR POWERED SURGICAL INSTRUMENT WITH DETACHABLE SHAFT ASSEMBLIES, now U.S. Patent Application Publication No. 2015/0272579;

U.S. patent application Ser. No. 14/226,093, entitled FEEDBACK ALGORITHMS FOR MANUAL BAILOUT SYSTEMS FOR SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272569;

U.S. patent application Ser. No. 14/226,116, entitled SURGICAL INSTRUMENT UTILIZING SENSOR ADAPTATION, now U.S. Patent Application Publication No. 2015/0272571;

U.S. patent application Ser. No. 14/226,071, entitled SURGICAL INSTRUMENT CONTROL CIRCUIT HAVING A SAFETY PROCESSOR, now U.S. Patent Application Publication No. 2015/0272578;

U.S. patent application Ser. No. 14/226,097, entitled SURGICAL INSTRUMENT COMPRISING INTERACTIVE SYSTEMS, now U.S. Patent Application Publication No. 2015/0272570;

U.S. patent application Ser. No. 14/226,126, entitled INTERFACE SYSTEMS FOR USE WITH SURGICAL INSTRUMENTS, now U.S. Patent Application Publication No. 2015/0272572;

U.S. patent application Ser. No. 14/226,133, entitled MODULAR SURGICAL INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2015/0272557;

U.S. patent application Ser. No. 14/226,081, entitled SYSTEMS AND METHODS FOR CONTROLLING A SEGMENTED CIRCUIT, now U.S. Patent Application Publication No. 2015/0277471;

U.S. patent application Ser. No. 14/226,076, entitled POWER MANAGEMENT THROUGH SEGMENTED CIRCUIT AND VARIABLE VOLTAGE PROTECTION, now U.S. Patent Application Publication No. 2015/0280424;

U.S. patent application Ser. No. 14/226,111, entitled SURGICAL STAPLING INSTRUMENT SYSTEM, now U.S. Patent Application Publication No. 2015/0272583; and

U.S. patent application Ser. No. 14/226,125, entitled SURGICAL INSTRUMENT COMPRISING A ROTATABLE SHAFT, now U.S. Patent Application Publication No. 2015/0280384.

Applicant of the present application also owns the following patent applications that were filed on Sep. 5, 2014 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/479,103, entitled CIRCUITRY AND SENSORS FOR POWERED MEDICAL DEVICE, now U.S. Patent Application Publication No. 2016/0066912;

U.S. patent application Ser. No. 14/479,119, entitled ADJUNCT WITH INTEGRATED SENSORS TO QUANTIFY TISSUE COMPRESSION, now U.S. Patent Application Publication No. 2016/0066914;

U.S. patent application Ser. No. 14/478,908, entitled MONITORING DEVICE DEGRADATION BASED ON COMPONENT EVALUATION, now U.S. Patent Application Publication No. 2016/0066910;

U.S. patent application Ser. No. 14/478,895, entitled MULTIPLE SENSORS WITH ONE SENSOR AFFECTING A SECOND SENSOR'S OUTPUT OR INTERPRETATION, now U.S. Patent Application Publication No. 2016/0066909;

U.S. patent application Ser. No. 14/479,110, entitled POLARITY OF HALL MAGNET TO DETECT MISLOADED CARTRIDGE, now U.S. Patent Application Publication No. 2016/0066915;

U.S. patent application Ser. No. 14/479,098, entitled SMART CARTRIDGE WAKE UP OPERATION AND DATA RETENTION, now U.S. Patent Application Publication No. 2016/0066911;

U.S. patent application Ser. No. 14/479,115, entitled MULTIPLE MOTOR CONTROL FOR POWERED MEDICAL DEVICE, now U.S. Patent Application Publication No. 2016/0066916; and

U.S. patent application Ser. No. 14/479,108, entitled LOCAL DISPLAY OF TISSUE PARAMETER STABILIZATION, now U.S. Patent Application Publication No. 2016/0066913.

Applicant of the present application also owns the following patent applications that were filed on Apr. 9, 2014 and which are each herein incorporated by reference in their respective entirety:

U.S. patent application Ser. No. 14/248,590, entitled MOTOR DRIVEN SURGICAL INSTRUMENTS WITH LOCKABLE DUAL DRIVE SHAFTS, now U.S. Patent Application Publication No. 2014/0305987;

U.S. patent application Ser. No. 14/248,581, entitled SURGICAL INSTRUMENT COMPRISING A CLOSING DRIVE AND A FIRING DRIVE OPERATED FROM THE SAME ROTATABLE OUTPUT, now U.S. Patent Application Publication No. 2014/0305989;

U.S. patent application Ser. No. 14/248,595, entitled SURGICAL INSTRUMENT SHAFT INCLUDING

SWITCHES FOR CONTROLLING THE OPERATION OF THE SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305988;

U.S. patent application Ser. No. 14/248,588, entitled POWERED LINEAR SURGICAL STAPLER, now U.S. Patent Application Publication No. 2014/0309666;

U.S. patent application Ser. No. 14/248,591, entitled TRANSMISSION ARRANGEMENT FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305991;

U.S. patent application Ser. No. 14/248,584, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH ALIGNMENT FEATURES FOR ALIGNING ROTARY DRIVE SHAFTS WITH SURGICAL END EFFECTOR SHAFTS, now U.S. Patent Application Publication No. 2014/0305994;

U.S. patent application Ser. No. 14/248,587, entitled POWERED SURGICAL STAPLER, now U.S. Patent Application Publication No. 2014/0309665;

U.S. patent application Ser. No. 14/248,586, entitled DRIVE SYSTEM DECOUPLING ARRANGEMENT FOR A SURGICAL INSTRUMENT, now U.S. Patent Application Publication No. 2014/0305990; and

U.S. patent application Ser. No. 14/248,607, entitled MODULAR MOTOR DRIVEN SURGICAL INSTRUMENTS WITH STATUS INDICATION ARRANGEMENTS, now U.S. Patent Application Publication No. 2014/0305992.

Applicant of the present application also owns the following patent applications that were filed on Apr. 16, 2013 and which are each herein incorporated by reference in their respective entirety:

U.S. Provisional Patent Application Ser. No. 61/812,365, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR;

U.S. Provisional Patent Application Ser. No. 61/812,376, entitled LINEAR CUTTER WITH POWER;

U.S. Provisional Patent Application Ser. No. 61/812,382, entitled LINEAR CUTTER WITH MOTOR AND PISTOL GRIP;

U.S. Provisional Patent Application Ser. No. 61/812,385, entitled SURGICAL INSTRUMENT HANDLE WITH MULTIPLE ACTUATION MOTORS AND MOTOR CONTROL; and

U.S. Provisional Patent Application Ser. No. 61/812,372, entitled SURGICAL INSTRUMENT WITH MULTIPLE FUNCTIONS PERFORMED BY A SINGLE MOTOR.

Numerous specific details are set forth to provide a thorough understanding of the overall structure, function, manufacture, and use of the embodiments as described in the specification and illustrated in the accompanying drawings. Well-known operations, components, and elements have not been described in detail so as not to obscure the embodiments described in the specification. The reader will understand that the embodiments described and illustrated herein are non-limiting examples, and thus it can be appreciated that the specific structural and functional details disclosed herein may be representative and illustrative. Variations and changes thereto may be made without departing from the scope of the claims.

The terms "comprise" (and any form of comprise, such as "comprises" and "comprising"), "have" (and any form of have, such as "has" and "having"), "include" (and any form of include, such as "includes" and "including") and "contain" (and any form of contain, such as "contains" and "containing") are open-ended linking verbs. As a result, a surgical system, device, or apparatus that "comprises," "has," "includes" or "contains" one or more elements possesses those one or more elements, but is not limited to possessing only those one or more elements. Likewise, an element of a system, device, or apparatus that "comprises," "has," "includes" or "contains" one or more features possesses those one or more features, but is not limited to possessing only those one or more features.

The terms "proximal" and "distal" are used herein with reference to a clinician manipulating the handle portion of the surgical instrument. The term "proximal" refers to the portion closest to the clinician and the term "distal" refers to the portion located away from the clinician. It will be further appreciated that, for convenience and clarity, spatial terms such as "vertical", "horizontal", "up", and "down" may be used herein with respect to the drawings. However, surgical instruments are used in many orientations and positions, and these terms are not intended to be limiting and/or absolute.

Various exemplary devices and methods are provided for performing laparoscopic and minimally invasive surgical procedures. However, the reader will readily appreciate that the various methods and devices disclosed herein can be used in numerous surgical procedures and applications including, for example, in connection with open surgical procedures. As the present Detailed Description proceeds, the reader will further appreciate that the various instruments disclosed herein can be inserted into a body in any way, such as through a natural orifice, through an incision or puncture hole formed in tissue, etc. The working portions or end effector portions of the instruments can be inserted directly into a patient's body or can be inserted through an access device that has a working channel through which the end effector and elongate shaft of a surgical instrument can be advanced.

A surgical stapling system can comprise a shaft and an end effector extending from the shaft. The end effector comprises a first jaw and a second jaw. The first jaw comprises a staple cartridge. The staple cartridge is insertable into and removable from the first jaw; however, other embodiments are envisioned in which a staple cartridge is not removable from, or at least readily replaceable from, the first jaw. The second jaw comprises an anvil configured to deform staples ejected from the staple cartridge. The second jaw is pivotable relative to the first jaw about a closure axis; however, other embodiments are envisioned in which the first jaw is pivotable relative to the second jaw. The surgical stapling system further comprises an articulation joint configured to permit the end effector to be rotated, or articulated, relative to the shaft. The end effector is rotatable about an articulation axis extending through the articulation joint. Other embodiments are envisioned which do not include an articulation joint.

The staple cartridge comprises a cartridge body. The cartridge body includes a proximal end, a distal end, and a deck extending between the proximal end and the distal end. In use, the staple cartridge is positioned on a first side of the tissue to be stapled and the anvil is positioned on a second side of the tissue. The anvil is moved toward the staple cartridge to compress and clamp the tissue against the deck. Thereafter, staples removably stored in the cartridge body can be deployed into the tissue. The cartridge body includes staple cavities defined therein wherein staples are removably stored in the staple cavities. The staple cavities are arranged in six longitudinal rows. Three rows of staple cavities are positioned on a first side of a longitudinal slot and three rows

of staple cavities are positioned on a second side of the longitudinal slot. Other arrangements of staple cavities and staples may be possible.

The staples are supported by staple drivers in the cartridge body. The drivers are movable between a first, or unfired position, and a second, or fired, position to eject the staples from the staple cavities. The drivers are retained in the cartridge body by a retainer which extends around the bottom of the cartridge body and includes resilient members configured to grip the cartridge body and hold the retainer to the cartridge body. The drivers are movable between their unfired positions and their fired positions by a sled. The sled is movable between a proximal position adjacent the proximal end and a distal position adjacent the distal end. The sled comprises a plurality of ramped surfaces configured to slide under the drivers and lift the drivers, and the staples supported thereon, toward the anvil.

Further to the above, the sled is moved distally by a firing member. The firing member is configured to contact the sled and push the sled toward the distal end. The longitudinal slot defined in the cartridge body is configured to receive the firing member. The anvil also includes a slot configured to receive the firing member. The firing member further comprises a first cam which engages the first jaw and a second cam which engages the second jaw. As the firing member is advanced distally, the first cam and the second cam can control the distance, or tissue gap, between the deck of the staple cartridge and the anvil. The firing member also comprises a knife configured to incise the tissue captured intermediate the staple cartridge and the anvil. It is desirable for the knife to be positioned at least partially proximal to the ramped surfaces such that the staples are ejected ahead of the knife.

FIGS. **1** and **3** depict a motor-driven surgical cutting and fastening instrument **1010** that may or may not be reused. In the illustrated embodiment, the instrument **1010** includes a previous housing **1012** that comprises a handle **1014** that is configured to be grasped, manipulated and actuated by the clinician. The housing **1012** is configured for operable attachment to an interchangeable shaft assembly **1200** that has a surgical end effector **1300** operably coupled thereto that is configured to perform one or more surgical tasks or procedures. As the present Detailed Description proceeds, it will be understood that the various forms of interchangeable shaft assemblies disclosed herein may also be effectively employed in connection with robotically-controlled surgical systems. Thus, the term "housing" may also encompass a housing or similar portion of a robotic system that houses or otherwise operably supports at least one drive system that is configured to generate and apply at least one control motion which could be used to actuate the interchangeable shaft assemblies disclosed herein and their respective equivalents. In addition, various components may be "housed" or contained in the housing or various components may be "associated with" a housing. In such instances, the components may not be contained with the housing or supported directly by the housing. The term "frame" may refer to a portion of a handheld surgical instrument. The term "frame" may also represent a portion of a robotically controlled surgical instrument and/or a portion of the robotic system that may be used to operably control a surgical instrument. For example, the interchangeable shaft assemblies disclosed herein may be employed with various robotic systems, instruments, components and methods disclosed in U.S. Pat. No. 9,072,535, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, that is incorporated by reference herein in its entirety.

The previous housing **1012** depicted in FIG. **1** is shown in connection with an interchangeable shaft assembly **1200** (FIGS. **2**, **4** and **5**) that includes an end effector **1300** that comprises a surgical cutting and fastening device that is configured to operably support a surgical staple cartridge **4000** therein. The housing **1012** may be configured for use in connection with interchangeable shaft assemblies that include end effectors that are adapted to support different sizes and types of staple cartridges, have different shaft lengths, sizes, and types, etc. In addition, the housing **1012** may also be effectively employed with a variety of other interchangeable shaft assemblies including those assemblies that are configured to apply other motions and forms of energy such as, for example, radio frequency (RF) energy, ultrasonic energy and/or motion to end effector arrangements adapted for use in connection with various surgical applications and procedures. Furthermore, the end effectors, shaft assemblies, handles, surgical instruments, and/or surgical instrument systems can utilize any suitable fastener, or fasteners, to fasten tissue. For instance, a fastener cartridge comprising a plurality of fasteners removably stored therein can be removably inserted into and/or attached to the end effector of a shaft assembly.

FIG. **1** illustrates the surgical instrument **1010** that includes an interchangeable shaft assembly **1200** operably coupled to the housing **1012**. FIG. **2** illustrates the interchangeable shaft assembly **1200** detached from the housing **1012** or handle **1014**. As can be seen in FIG. **3**, the handle **1014** may comprise a pair of interconnectable handle housing segments **1016** and **1018** that may be interconnected by screws, snap features, adhesive, etc. In the illustrated arrangement, the handle housing segments **1016**, **1018** cooperate to form a pistol grip portion **1019** that can be gripped and manipulated by the clinician. As will be discussed in further detail below, the handle **1014** operably supports a plurality of drive systems therein that are configured to generate and apply various control motions to corresponding portions of the interchangeable shaft assembly that is operably attached thereto.

Referring now to FIG. **3**, the handle **1014** may further include a frame **1020** that operably supports a plurality of drive systems. For example, the frame **1020** can operably support a "first" or closure drive system, generally designated as **1030**, which may be employed to apply closing and opening motions to the interchangeable shaft assembly **1200** that is operably attached or coupled thereto. In at least one form, the closure drive system **1030** may include an actuator in the form of a closure trigger **1032** that is pivotally supported by the frame **1020**. More specifically, as illustrated in FIG. **3**, the closure trigger **1032** is pivotally coupled to the housing **1014** by a pin **1033**. Such arrangement enables the closure trigger **1032** to be manipulated by a clinician such that when the clinician grips the pistol grip portion **1019** of the handle **1014**, the closure trigger **1032** may be easily pivoted from a starting or "unactuated" position to an "actuated" position and more particularly to a fully compressed or fully actuated position. The closure trigger **1032** may be biased into the unactuated position by spring or other biasing arrangement (not shown). In various forms, the closure drive system **1030** further includes a closure linkage assembly **1034** that is pivotally coupled to the closure trigger **1032**. As can be seen in FIG. **3**, the closure linkage assembly **1034** may include a first closure link **1036** and a second closure link **1038** that are pivotally

coupled to the closure trigger **1032** by a pin **1035**. The second closure link **1038** may also be referred to herein as an "attachment member" and include a transverse attachment pin **1037**.

Still referring to FIG. **3**, it can be observed that the first closure link **1036** may have a locking wall or end **1039** thereon that is configured to cooperate with a closure release assembly **1060** that is pivotally coupled to the frame **1020**. In at least one form, the closure release assembly **1060** may comprise a release button assembly **1062** that has a distally protruding locking pawl **1064** formed thereon. The release button assembly **1062** may be pivoted in a counterclockwise direction by a release spring (not shown). As the clinician depresses the closure trigger **1032** from its unactuated position towards the pistol grip portion **1019** of the handle **1014**, the first closure link **1036** pivots upward to a point wherein the locking pawl **1064** drops into retaining engagement with the locking wall **1039** on the first closure link **1036** thereby preventing the closure trigger **1032** from returning to the unactuated position. Thus, the closure release assembly **1060** serves to lock the closure trigger **1032** in the fully actuated position. When the clinician desires to unlock the closure trigger **1032** to permit it to be biased to the unactuated position, the clinician simply pivots the closure release button assembly **1062** such that the locking pawl **1064** is moved out of engagement with the locking wall **1039** on the first closure link **1036**. When the locking pawl **1064** has been moved out of engagement with the first closure link **1036**, the closure trigger **1032** may pivot back to the unactuated position. Other closure trigger locking and release arrangements may also be employed.

An arm **1061** may extend from the closure release button **1062**. A magnetic element **1063**, such as a permanent magnet, for example, may be mounted to the arm **1061**. When the closure release button **1062** is rotated from its first position to its second position, the magnetic element **1063** can move toward a circuit board **1100**. The circuit board **1100** can include at least one sensor that is configured to detect the movement of the magnetic element **1063**. In at least one embodiment, for example, a "Hall Effect" sensor (not shown) can be mounted to the bottom surface of the circuit board **1100**. The Hall Effect sensor can be configured to detect changes in a magnetic field surrounding the Hall Effect sensor caused by the movement of the magnetic element **1063**. The Hall Effect sensor can be in signal communication with a microcontroller, for example, which can determine whether the closure release button **1062** is in its first position, which is associated with the unactuated position of the closure trigger **1032** and the open configuration of the end effector, its second position, which is associated with the actuated position of the closure trigger **1032** and the closed configuration of the end effector, and/or any position between the first position and the second position.

In at least one form, the handle **1014** and the frame **1020** may operably support another drive system referred to herein as a firing drive system **1080** that is configured to apply firing motions to corresponding portions of the interchangeable shaft assembly attached thereto. The firing drive system may **1080** also be referred to herein as a "second drive system". The firing drive system **1080** may employ an electric motor **1082** that is located in the pistol grip portion **1019** of the handle **1014**. In various forms, the motor **1082** may be a DC brushed driving motor having a maximum rotation of, approximately, 25,000 RPM, for example. In other arrangements, the motor may include a brushless motor, a cordless motor, a synchronous motor, a stepper motor, or any other suitable electric motor. The motor **1082** may be powered by a power source **1090** that in one form may comprise a removable power pack **1092**. As can be seen in FIG. **3**, for example, the power pack **1092** may comprise a proximal housing portion **1094** that is configured for attachment to a distal housing portion **1096**. The proximal housing portion **1094** and the distal housing portion **1096** are configured to operably support a plurality of batteries **1098** therein. Batteries **1098** may each comprise, for example, a Lithium Ion ("LI") or other suitable battery. The distal housing portion **1096** is configured for removable operable attachment to the circuit board assembly **1100** which is also operably coupled to the motor **1082**. A number of batteries **1098** may be connected in series may be used as the power source for the surgical instrument **1010**. In addition, the power source **1090** may be replaceable and/or rechargeable.

As outlined above with respect to other various forms, the electric motor **1082** can include a rotatable shaft (not shown) that operably interfaces with a gear reducer assembly **1084** that is mounted in meshing engagement with a with a set, or rack, of drive teeth **1122** on a longitudinally-movable drive member **1120**. In use, a voltage polarity provided by the power source **1090** can operate the electric motor **1082** in a clockwise direction wherein the voltage polarity applied to the electric motor by the battery can be reversed in order to operate the electric motor **1082** in a counter-clockwise direction. When the electric motor **1082** is rotated in one direction, the drive member **1120** will be axially driven in the distal direction "DD". When the motor **82** is driven in the opposite rotary direction, the drive member **1120** will be axially driven in a proximal direction "PD". The handle **1014** can include a switch which can be configured to reverse the polarity applied to the electric motor **1082** by the power source **1090**. As with the other forms described herein, the handle **1014** can also include a sensor that is configured to detect the position of the drive member **1120** and/or the direction in which the drive member **1120** is being moved.

Actuation of the motor **1082** can be controlled by a firing trigger **1130** that is pivotally supported on the handle **1014**. The firing trigger **1130** may be pivoted between an unactuated position and an actuated position. The firing trigger **1130** may be biased into the unactuated position by a spring **1132** or other biasing arrangement such that when the clinician releases the firing trigger **1130**, it may be pivoted or otherwise returned to the unactuated position by the spring **1132** or biasing arrangement. In at least one form, the firing trigger **1130** can be positioned "outboard" of the closure trigger **132** as was discussed above. In at least one form, a firing trigger safety button **1134** may be pivotally mounted to the closure trigger **1032** by pin **1035**. The safety button **1134** may be positioned between the firing trigger **1130** and the closure trigger **1032** and have a pivot arm **1136** protruding therefrom. See FIG. **21**. When the closure trigger **1032** is in the unactuated position, the safety button **1134** is contained in the handle **1014** where the clinician cannot readily access it and move it between a safety position preventing actuation of the firing trigger **1130** and a firing position wherein the firing trigger **1130** may be fired. As the clinician depresses the closure trigger **1032**, the safety button **1134** and the firing trigger **1130** pivot down wherein they can then be manipulated by the clinician.

As indicated above, in at least one form, the longitudinally movable drive member **1120** has a rack of teeth **1122** formed thereon for meshing engagement with a corresponding drive gear **1086** of the gear reducer assembly **1084**. At least one form also includes a manually-actuatable "bailout"

assembly **1140** that is configured to enable the clinician to manually retract the longitudinally movable drive member **1120** should the motor **1082** become disabled. The bailout assembly **1140** may include a lever or bailout handle assembly **1142** that is configured to be manually pivoted into ratcheting engagement with teeth **1124** also provided in the drive member **1120**. Thus, the clinician can manually retract the drive member **1120** by using the bailout handle assembly **1142** to ratchet the drive member **1120** in the proximal direction "PD". U.S. Pat. No. 8,608,045, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, discloses bailout arrangements and other components, arrangements and systems that may also be employed with the various instruments disclosed herein. U.S. Pat. No. 8,608,045, is hereby incorporated by reference herein in its entirety.

Turning now to FIGS. **2** and **5**, the interchangeable shaft assembly **1200** includes a surgical end effector **1300** that comprises an elongate channel **1310** that is configured to operably support a staple cartridge **4000** therein. The end effector **1300** may further include an anvil **2000** that is pivotally supported relative to the elongate channel **1310**. The interchangeable shaft assembly **1200** may further include an articulation joint **3020** and an articulation lock **2140** which can be configured to releasably hold the end effector **1300** in a desired position relative to a shaft axis SA. Examples of various features of at least one form of the end effector **1300**, the articulation joint **3020** and articulation locks may be found in U.S. patent application Ser. No. 13/803,086, filed Mar. 14, 2013, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK. The entire disclosure of U.S. patent application Ser. No. 13/803,086, filed Mar. 14, 2013, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING AN ARTICULATION LOCK is hereby incorporated by reference herein. As can be seen in FIG. **4**, the interchangeable shaft assembly **1200** can further include a proximal housing or nozzle **1201** comprised of nozzle portions **1202** and **1203**.

The interchangeable shaft assembly **1200** can further include a closure system or closure member assembly **3000** which can be utilized to close and/or open the anvil **2000** of the end effector **1300**. The shaft assembly **1200** can include a spine **1210** that is configured to, one, slidably support a firing member therein and, two, slidably support the closure member assembly **3000** which extends around the spine **1210**. As can be seen in FIG. **5**, a distal end **1211** of spine **1210** terminates in an upper lug mount feature **1270** and in a lower lug mount feature **1280**. The upper lug mount feature **1270** is formed with a lug slot **1272** therein that is adapted to mountingly support an upper mounting link **1274** therein. Similarly, the lower lug mount feature **1280** is formed with a lug slot **1282** therein that is adapted to mountingly support a lower mounting link **1284** therein. The upper mounting link **1274** includes a pivot socket **1276** therein that is adapted to rotatably receive therein a pivot pin **1292** that is formed on a channel cap or anvil retainer **1290** that is attached to a proximal end portion **1312** of the elongate channel **1310**. The lower mounting link **1284** includes lower pivot pin **1286** that adapted to be received within a pivot hole **1314** formed in the proximal end portion **1312** of the elongate channel **1310**. See FIG. **5**. The lower pivot pin **1286** is vertically aligned with the pivot socket **1276** to define an articulation axis AA about which the surgical end effector **1300** may articulate relative to the shaft axis SA. See FIG. **2**.

In the illustrated example, the surgical end effector **1300** is selectively articulatable about the articulation axis AA by an articulation system **2100**. In one form, the articulation system **2100** includes proximal articulation driver **2102** that is pivotally coupled to an articulation link **2120**. As can be most particularly seen in FIG. **5**, an offset attachment lug **2114** is formed on a distal end **2112** of the proximal articulation driver **2102**. A pivot hole **2116** is formed in the offset attachment lug **2114** and is configured to pivotally receive therein a proximal link pin **2124** formed on the proximal end **2122** of the articulation link **3020**. A distal end **2126** of the articulation link **2120** includes a pivot hole **2128** that is configured to pivotally receive therein a channel pin **1317** formed on the proximal end portion **1312** of the elongate channel **1310**. Thus, axial movement of proximal articulation driver **2102** will thereby apply articulation motions to the elongate channel **1310** to thereby cause the surgical end effector **1300** to articulate about the articulation axis AA relative to the spine assembly **1210**. Further details concerning the construction and operation of the articulation system **2100** may be found in various references incorporated by reference herein including U.S. patent application Ser. No. 15/635,631, filed Jun. 28, 2017, entitled SURGICAL INSTRUMENT WITH AXIALLY MOVABLE CLOSURE MEMBER, the entire disclosure of which is hereby incorporated by reference herein. In various circumstances, the proximal articulation driver **2102** can be held in position by an articulation lock **2140** when the proximal articulation driver **2102** is not being moved in the proximal or distal directions. Additional details regarding an example of an articulation lock **2140** may be found in U.S. patent application Ser. No. 15/635,631 as well as in other references incorporated by reference herein.

In various circumstances, the spine **1210** can comprise a proximal end **1211** which is rotatably supported in a chassis **1240**. In one arrangement, for example, the proximal end **1211** of the spine **1210** has a thread **1214** formed thereon for threaded attachment to a spine bearing **1216** configured to be supported within the chassis **1240**. See FIG. **4**. Such an arrangement facilitates rotatable attachment of the spine **1210** to the chassis **1240** such that the spine **1210** may be selectively rotated about a shaft axis SA relative to the chassis **1240**.

Referring primarily to FIG. **4**, the interchangeable shaft assembly **1200** includes a closure shuttle **1250** that is slidably supported within the chassis **1240** such that it may be axially moved relative thereto. The closure shuttle **1250** includes a pair of proximally-protruding hooks **1252** that are configured for attachment to the attachment pin **1037** (FIGS. **2** and **3**) that is attached to the second closure link **1038** as will be discussed in further detail below. In at least one example, the closure member assembly **3000** comprises a proximal closure member segment **3010** that has a proximal end **3012** that is coupled to the closure shuttle **1250** for relative rotation thereto. For example, a U shaped connector **1263** is inserted into an annular slot **3014** in the proximal end **3012** of the proximal closure member segment **3010** and is retained within vertical slots **1253** in the closure shuttle **1250**. Such an arrangement serves to attach the proximal closure tube segment **3010** to the closure shuttle **1250** for axial travel therewith while enabling the proximal closure tube segment **3010** to rotate relative to the closure shuttle **1250** about the shaft axis SA. A closure spring **1268** is journaled on the proximal closure tube segment **3010** and serves to bias the proximal closure tube segment **3010** in the proximal direction "PD" which can serve to pivot the

closure trigger **1032** into the unactuated position when the shaft assembly is operably coupled to the handle **1014**.

In at least one form, the interchangeable shaft assembly **1200** may further include an articulation joint **3020**. Other interchangeable shaft assemblies, however, may not be capable of articulation. As can be seen in FIG. **5**, for example, a distal closure member or distal closure tube segment **3030** is coupled to the distal end of the proximal closure member or proximal closure tube segment **3010**. The articulation joint **3020** includes a double pivot closure sleeve assembly **3022**. According to various forms, the double pivot closure sleeve assembly **3022** includes an end effector closure tube **3050** having upper and lower distally projecting tangs **3052**, **3054**. An upper double pivot link **3056** includes upwardly projecting distal and proximal pivot pins that engage respectively an upper distal pin hole in the upper proximally projecting tang **3052** and an upper proximal pin hole in an upper distally projecting tang **3032** on the distal closure tube segment **3030**. A lower double pivot link **3058** includes upwardly projecting distal and proximal pivot pins that engage respectively a lower distal pin hole in the lower proximally projecting tang **3054** and a lower proximal pin hole in the lower distally projecting tang **3034**. See FIGS. **4** and **5**. As will be discussed in further detail below, the closure tube assembly **3000** is translated distally (direction "DD") to close the anvil **2000**, for example, in response to the actuation of the closure trigger **1032**. The anvil **2000** is opened by proximally translating the closure tube assembly **3000** which causes the end effector closure sleeve to interact with the anvil **2000** and pivot it to an open position.

As was also indicated above, the interchangeable shaft assembly **1200** further includes a firing member **1900** that is supported for axial travel within the shaft spine **1210**. The firing member includes an intermediate firing shaft portion **1222** that is configured for attachment to a distal cutting portion or knife bar **1910**. The intermediate firing shaft portion **1222** may include a longitudinal slot **1223** in the distal end thereof which can be configured to receive a tab **1912** on the proximal end of the distal knife bar **1910**. The longitudinal slot **1223** and the proximal end tab **1912** can be sized and configured to permit relative movement therebetween and can comprise a slip joint. The slip joint **1914** can permit the intermediate firing shaft portion **1222** of the firing drive to be moved to articulate the end effector **1300** without moving, or at least substantially moving, the knife bar **1910**. Once the end effector **1300** has been suitably oriented, the intermediate firing shaft portion **1222** can be advanced distally until a proximal sidewall of the longitudinal slot **1223** comes into contact with the tab **1912** in order to advance the knife bar **1910** and fire the staple cartridge **4000** positioned within the channel **1310**. The knife bar **1910** includes a knife portion **1920** that includes a blade or tissue cutting edge **1922** and includes an upper anvil engagement tab **1924** and lower channel engagement tabs **1926**. Various firing member configurations and operations are disclosed in various other references incorporated herein by reference.

As can be seen in FIG. **4**, the shaft assembly **1200** further includes a switch drum **1500** that is rotatably received on the closure tube **1260**. The switch drum **1500** comprises a hollow shaft segment **1502** that has a shaft boss formed thereon for receive an outwardly protruding actuation pin therein. In various circumstances, the actuation pin extends through a longitudinal slot provided in the lock sleeve to facilitate axial movement of the lock sleeve when it is engaged with the articulation driver. A rotary torsion spring **1420** is configured to engage the boss on the switch drum **1500** and a portion of the nozzle housing **1203** to apply a biasing force to the switch drum **1500**. The switch drum **1500** can further comprise at least partially circumferential openings **1506** defined therein which can be configured to receive circumferential mounts extending from the nozzle halves **1202**, **1203** and permit relative rotation, but not translation, between the switch drum **1500** and the proximal nozzle **1201**. The mounts also extend through openings **3011** in the proximal closure tube segment **3010** to be seated in recesses **1219** in the spine shaft **1210**. Rotation of the switch drum **1500** about the shaft axis SA will ultimately result in the rotation of the actuation pin and the lock sleeve between its engaged and disengaged positions. In one arrangement, the rotation of the switch drum **1500** may be linked to the axial advancement of the closure tube or closure member. Thus, in essence, actuation of the closure system may operably engage and disengage the articulation drive system with the firing drive system in the various manners described in further detail in U.S. patent application Ser. No. 13/803,086 and U.S. Pat. No. 9,913,642, entitled SURGICAL INSTRUMENT COMPRISING A SENSOR SYSTEM, the entire disclosures of each being hereby incorporated by reference herein. For example, when the closure tube is in its proximal-most position corresponding to a "jaws open" position, the closure tube segment **3010** will have positioned the switch drum **1500** so as to link the articulation system with the firing drive system. When, the closure tube has been moved to its distal position corresponding to a "jaws closed" position, the closure tube has rotated the switch drum **1500** to a position wherein the articulation system is delinked from the firing drive system.

As also illustrated in FIG. **4**, the shaft assembly **1200** can comprise a slip ring assembly **1600** which can be configured to conduct electrical power to and/or from the end effector **1300** and/or communicate signals to and/or from the end effector **1300**, for example. The slip ring assembly **1600** can comprise a proximal connector flange **1604** that is mounted to a chassis flange **1242** that extends from the chassis **1240** and a distal connector flange that is positioned within a slot defined in the shaft housings. The proximal connector flange **1604** can comprise a first face and the distal connector flange can comprise a second face which is positioned adjacent to and movable relative to the first face. The distal connector flange can rotate relative to the proximal connector flange **1604** about the shaft axis SA. The proximal connector flange **1604** can comprise a plurality of concentric, or at least substantially concentric, conductors defined in the first face thereof. A connector can be mounted on the proximal side of the connector flange and may have a plurality of contacts wherein each contact corresponds to and is in electrical contact with one of the conductors. Such an arrangement permits relative rotation between the proximal connector flange **1604** and the distal connector flange while maintaining electrical contact therebetween. The proximal connector flange **1604** can include an electrical connector **1606** which can place the conductors in signal communication with a shaft circuit board **1610** mounted to the shaft chassis **1240**, for example. In at least one instance, a wiring harness comprising a plurality of conductors can extend between the electrical connector **1606** and the shaft circuit board **1610**. The electrical connector **1606** may extend proximally through a connector opening **1243** defined in the chassis mounting flange **1242**. See FIG. **4**. Further details regarding slip ring assembly **1600** may be found in U.S. patent application Ser. No. 13/803,086, U.S. patent application Ser. No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on Mar. 13, 2013, and U.S. Pat. No. 9,345,481, entitled STAPLE CAR-

TRIDGE TISSUE THICKNESS SENSOR SYSTEM, for example. U.S. patent application Ser. No. 13/803,086, U.S. patent application Ser. No. 13/800,067 and U.S. Pat. No. 9,345,481 are each hereby incorporated by reference herein in their respective entireties.

As discussed above, the shaft assembly **1200** can include a proximal portion which is fixably mounted to the handle **1014** and a distal portion which is rotatable about a longitudinal axis. The rotatable distal shaft portion can be rotated relative to the proximal portion about the slip ring assembly **1600**, as discussed above. The distal connector flange of the slip ring assembly **1600** can be positioned within the rotatable distal shaft portion. Moreover, further to the above, the switch drum **1500** can also be positioned within the rotatable distal shaft portion. When the rotatable distal shaft portion is rotated, the distal connector flange and the switch drum **1500** can be rotated synchronously with one another. In addition, the switch drum **1500** can be rotated between a first position and a second position relative to the distal connector flange. When the switch drum **1500** is in its first position, the articulation drive system may be operably disengaged from the firing drive system and, thus, the operation of the firing drive system may not articulate the end effector **1300** of the shaft assembly **1200**. When the switch drum **1500** is in its second position, the articulation drive system may be operably engaged with the firing drive system and, thus, the operation of the firing drive system may articulate the end effector **1300** of the shaft assembly **1200**. When the switch drum **1500** is moved between its first position and its second position, the switch drum **1500** is moved relative to distal connector flange. In various instances, the shaft assembly **1200** can comprise at least one sensor configured to detect the position of the switch drum **1500**.

Referring again to FIG. **4**, the chassis **1240** includes at least one, and preferably two, tapered attachment portions **1244** formed thereon that are adapted to be received within corresponding dovetail slots **1702** formed within a distal attachment flange portion **1700** of the frame **1020**. See FIG. **3**. Each dovetail slot **1702** may be tapered or, stated another way, be somewhat V-shaped to seatingly receive the attachment portions **1244** therein. As can be further seen in FIG. **22**, a shaft attachment lug **1226** is formed on the proximal end of the intermediate firing shaft **1222**. As will be discussed in further detail below, when the interchangeable shaft assembly **1200** is coupled to the handle **1014**, the shaft attachment lug **1226** is received in a firing shaft attachment cradle **1126** formed in the distal end **1125** of the longitudinal drive member **1120**. See FIG. **3**.

Various shaft assembly embodiments employ a latch system **1710** for removably coupling the shaft assembly **1200** to the housing **1012** and more specifically to the frame **1020**. As can be seen in FIG. **4**, for example, in at least one form, the latch system **1710** includes a lock member or lock yoke **1712** that is movably coupled to the chassis **1240**. In the illustrated embodiment, for example, the lock yoke **1712** has a U-shape with two spaced downwardly extending legs **1714**. The legs **1714** each have a pivot lug **1715** formed thereon that are adapted to be received in corresponding holes **1245** formed in the chassis **1240**. Such arrangement facilitates pivotal attachment of the lock yoke **1712** to the chassis **1240**. The lock yoke **1712** may include two proximally protruding lock lugs **1716** that are configured for releasable engagement with corresponding lock detents or grooves **1704** in the distal attachment flange **1700** of the frame **1020**. See FIG. **3**. In various forms, the lock yoke **1712** is biased in the proximal direction by spring or biasing member (not shown). Actuation of the lock yoke **1712** may be accomplished by a latch button **1722** that is slidably mounted on a latch actuator assembly **1720** that is mounted to the chassis **1240**. The latch button **1722** may be biased in a proximal direction relative to the lock yoke **1712**. As will be discussed in further detail below, the lock yoke **1712** may be moved to an unlocked position by biasing the latch button the in distal direction which also causes the lock yoke **1712** to pivot out of retaining engagement with the distal attachment flange **1700** of the frame **1020**. When the lock yoke **1712** is in "retaining engagement" with the distal attachment flange **1700** of the frame **1020**, the lock lugs **1716** are retainingly seated within the corresponding lock detents or grooves **1704** in the distal attachment flange **1700**.

When employing an interchangeable shaft assembly that includes an end effector of the type described herein that is adapted to cut and fasten tissue, as well as other types of end effectors, it may be desirable to prevent inadvertent detachment of the interchangeable shaft assembly from the housing during actuation of the end effector. For example, in use the clinician may actuate the closure trigger **1032** to grasp and manipulate the target tissue into a desired position. Once the target tissue is positioned within the end effector **1300** in a desired orientation, the clinician may then fully actuate the closure trigger **1032** to close the anvil **1306** and clamp the target tissue in position for cutting and stapling. In that instance, the first drive system **1030** has been fully actuated. After the target tissue has been clamped in the end effector **1300**, it may be desirable to prevent the inadvertent detachment of the shaft assembly **1200** from the housing **1012**. One form of the latch system **1710** is configured to prevent such inadvertent detachment.

As can be most particularly seen in FIG. **4**, the lock yoke **1712** includes at least one and preferably two lock hooks **1718** that are adapted to contact corresponding lock lug portions **1256** that are formed on the closure shuttle **1250**. When the closure shuttle **1250** is in an unactuated position (i.e., the first drive system **1030** is unactuated and the anvil **1306** is open), the lock yoke **1712** may be pivoted in a distal direction to unlock the interchangeable shaft assembly **1200** from the housing **1012**. When in that position, the lock hooks **1718** do not contact the lock lug portions **1256** on the closure shuttle **1250**. However, when the closure shuttle **1250** is moved to an actuated position (i.e., the first drive system **1030** is actuated and the anvil **1306** is in the closed position), the lock yoke **1712** is prevented from being pivoted to an unlocked position. Stated another way, if the clinician were to attempt to pivot the lock yoke **1712** to an unlocked position or, for example, the lock yoke **1712** was in advertently bumped or contacted in a manner that might otherwise cause it to pivot distally, the lock hooks **1718** on the lock yoke **1712** will contact the lock lugs **1256** on the closure shuttle **1250** and prevent movement of the lock yoke **1712** to an unlocked position.

Attachment of the interchangeable shaft assembly **1200** to the handle **1014** will now be described. To commence the coupling process, the clinician may position the chassis **1240** of the interchangeable shaft assembly **1200** above or adjacent to the distal attachment flange **1700** of the frame **1020** such that the tapered attachment portions **1244** formed on the chassis **1240** are aligned with the dovetail slots **1702** in the frame **1020**. The clinician may then move the shaft assembly **1200** along an installation axis that is perpendicular to the shaft axis SA to seat the attachment portions **1244** in "operable engagement" with the corresponding dovetail receiving slots **1702**. In doing so, the shaft attachment lug **1226** on the intermediate firing shaft **1222** will also be seated in the cradle **1126** in the longitudinally movable drive

member **1120** and the portions of pin **1037** on the second closure link **1038** will be seated in the corresponding hooks **1252** in the closure yoke **1250**. As used herein, the term "operable engagement" in the context of two components means that the two components are sufficiently engaged with each other so that upon application of an actuation motion thereto, the components may carry out their intended action, function and/or procedure.

At least five systems of the interchangeable shaft assembly **1200** can be operably coupled with at least five corresponding systems of the handle **1014**. A first system can comprise a frame system which couples and/or aligns the frame or spine of the shaft assembly **1200** with the frame **1020** of the handle **1014**. Another system can comprise a closure drive system **1030** which can operably connect the closure trigger **1032** of the handle **1014** and the closure tube **1260** and the anvil **2000** of the shaft assembly **1200**. As outlined above, the closure tube attachment yoke **1250** of the shaft assembly **1200** can be engaged with the pin **1037** on the second closure link **1038**. Another system can comprise the firing drive system **1080** which can operably connect the firing trigger **1130** of the handle **1014** with the intermediate firing shaft **1222** of the shaft assembly **1200**. As outlined above, the shaft attachment lug **1226** can be operably connected with the cradle **1126** of the longitudinal drive member **1120**. Another system can comprise an electrical system which can signal to a controller in the handle **1014**, such as microcontroller, for example, that a shaft assembly, such as shaft assembly **1200**, for example, has been operably engaged with the handle **1014** and/or, two, conduct power and/or communication signals between the shaft assembly **1200** and the handle **1014**. For instance, the shaft assembly **1200** can include an electrical connector **1810** that is operably mounted to the shaft circuit board **1610**. The electrical connector **1810** is configured for mating engagement with a corresponding electrical connector **1800** on the handle control board **1100**. Further details regaining the circuitry and control systems may be found in U.S. patent application Ser. No. 13/803,086, and U.S. patent application Ser. No. 14/226,142, the entire disclosures of each which were previously incorporated by reference herein. The fifth system may consist of the latching system for releasably locking the shaft assembly **1200** to the handle **1014**.

Referring now to FIGS. **5-7**, the anvil **2000** in the illustrated example includes an anvil body **2002** that terminates in anvil mounting portion **2010**. The anvil mounting portion **2010** is movably or pivotably supported on the elongate channel **1310** for selective pivotal travel relative thereto about a fixed anvil pivot axis PA that is transverse to the shaft axis SA. In the illustrated arrangement, a pivot member or anvil trunnion **2012** extends laterally out of each lateral side of the anvil mounting portion **2010** to be received in a corresponding trunnion cradle **1316** formed in the upstanding walls **1315** of the proximal end portion **1312** of the elongate channel **1310**. The anvil trunnions **2012** are pivotally retained in their corresponding trunnion cradle **1316** by the channel cap or anvil retainer **1290**. The channel cap or anvil retainer **1290** includes a pair of attachment lugs that are configured to be retainingly received within corresponding lug grooves or notches formed in the upstanding walls **1315** of the proximal end portion **1312** of the elongate channel **1310**.

Referring to FIGS. **7**, **8** and **9**, in at least one arrangement, the distal closure member or end effector closure tube **3050** employs two axially offset, proximal and distal positive jaw opening features **3060** and **3062**. In FIG. **7**, the proximal positive jaw opening feature **2060** is located on the right side (as viewed by a user of the tool assembly) of the shaft axis SA. The positive jaw opening features **3060**, **3062** are configured to interact with corresponding relieved areas **3064**, **3066** and stepped portions formed on the anvil mounting portion **2010** as described in further detail in U.S. patent application Ser. No. 15/635,631, filed Jun. 28, 2017, entitled SURGICAL INSTRUMENT WITH AXIALLY MOVABLE CLOSURE MEMBER, the entire disclosure which has been herein incorporated by reference. Other jaw opening arrangements may be employed.

FIGS. **6** and **7** illustrate one form of an anvil **2000** that includes an elongate anvil body portion **2002** that terminates in an mounting portion **2010** that is configured to interact with the end effector closure sleeve **3050** to minimize the amount of resultant forces experienced by the end effector closure tube **3050** as the anvil **2000** is moved from a fully open position to a closed position and ultimately an over-closed position. The anvil body portion **2002** includes a staple-forming undersurface **2004** that has a series of anvil forming pockets (not shown) formed therein. An elongate slot **2006** extends through the body portion **2002** and the mounting portion **2010** to facilitate passage of the knife portion or "firing member" **1920** therethrough. In addition, an anvil cover **2030** is attached to the anvil body **2002** to cover the slot **2006**. In various circumstances, the anvil mounting portion **2010** comprises anvil cam surface **2020** formed thereon. The anvil cam surface **2020** is bisected or otherwise split by the elongate slot **2006**. As can be seen in FIGS. **6** and **7**, a proximal end portion **2032** of the anvil cover **2030** is oriented at an angle that corresponds to the angle/orientation of the anvil cam surfaces **2020**. FIGS. **10** and **11** illustrate the anvil **2000** in a fully open position. As can be seen in FIG. **10**, the distal or end effector closure tube **3050** is in its proximal most position when the "second jaw" or anvil **2000** is in its fully open position. When in that position, a cam surface **3072** formed on the distal end **3070** of the end effector closure tube **3050** is not applying any closure forces to the cam closure surfaces **2020**. As the end effector closure tube **3050** is moved distally, the cam surface **3072** on the end effector closure tube **3050** contacts the cam closure surfaces **2020** on the anvil mounting portion **2010** and a corresponding closure surface **2034** on the proximal end portion **2032** of the anvil cover **2030** to pivot the anvil **2000** into a "closed" position. FIGS. **12** and **13** illustrate the positions of the end effector closure tube **3050** and the anvil **2000** when the anvil **2000** is in the closed position.

As the end effector closure tube **3050** continues to be advanced distally to apply additional closure motions to the anvil to ultimately move the anvil to an "over-closed" position, the end effector closure tube may experience significant stress which may, overtime, cause the end effector closure tube to become elongated vertically (when viewed from an end) or, stated another way, become somewhat oval in shape which may ultimately lead to failure or otherwise detrimentally effect the ability to attain a fully closed position. It is axiomatic that when a thin-walled tube or cylinder is subjected to internal pressure, a "hoop" and longitudinal stress are produced in the wall of the tube. This hoop stress is acting circumferential and perpendicular to the axis and radius of the cylinder wall. Such hoop stress may be calculated as:

$\sigma_h = pd/(2t)$, where:

σ_h=hoop stress (MPa, psi)
p=internal pressure in the tube or cylinder (MPa, psi)
d=internal diameter of tube or cylinder (mm, in)
t=tube or cylinder wall thickness (mm, in)

End effector closure tubes with various tube wall configurations have been developed. Examples of such tube configurations are disclosed in U.S. patent application Ser. No. 15/385,903, filed Dec. 21, 2016, entitled CLOSURE MEMBER ARRANGEMENTS FOR SURGICAL INSTRUMENTS, the entire disclosure of which is hereby incorporated by reference herein.

FIGS. **8** and **9** illustrate one form of an end effector closure tube **3050**. The closure tube **3050** comprises an external surface **3074** and an internal wall surface **3076**. In at least one form, the closure tube **3050** comprises a constant internal diameter ID and a constant external diameter OD to define a wall thickness CT that is uniform or constant throughout a length of the closure tube **3050** or at least the portion of the closure tube that is configured to interface with the end effector jaws such as the anvil **2000** and the elongate channel **1310**.

Returning now to FIG. **12**, in at least one arrangement, when the anvil **2000** is in the "closed position", a clearance distance "CD" may be observed between the staple-forming underside **2004** of the anvil body **2002** and the cartridge deck surface of a cartridge that is supported within the elongate channel **1310** when no tissue is clamped between the anvil **2000** and the cartridge. FIG. **13** is a cross-sectional view taken along line **13-13** in FIG. **12** across the closure cam surfaces **2020** as well as through a distal end portion of the end effector closure tube **3050** as well as the anvil mounting portion **2020** and the proximal end portion of the elongate channel **1310**. As can be seen in that Figure, various closure forces CF are applied to the anvil **2000** and elongate channel **1310** by the end effector closure tube **3050**. For example, closure forces CF are applied onto the closure cam surfaces **2020** and the proximal end portion **2032** of the anvil cap **2030** as well as onto the elongate channel **1310**.

In the example illustrated in FIGS. **6-15**, the anvil mounting portion **2020** is formed to establish a plurality of discrete load transfer locations that are configured to be contacted by the inner surface **3076** of the end effector closure tube **3050** when the end effector closure tube **3050** is in the position corresponding to the closed position of the anvil **2000**. In at least one arrangement, at least two discrete load transfer locations are located on each side of a vertical plane VP that bisects the anvil **2000** when the anvil **2000** is in the closed position. For example, in FIG. **13**, a first right load transfer location or edge **2070**R, a second right load transfer location or edge **2072**R, a third right load transfer location or edge **2074**R and a fourth right load transfer location or edge **2076**R are formed on a right side of the vertical plane VP. Similarly, a first left load transfer location or edge **2070**L, a second left load transfer location or edge **2072**L, a third left load transfer location or edge **2074**L and a fourth left load transfer location or edge **2076**L are formed on a left side of the vertical plane VP. As used in this context, the term "at least two discrete load transfer locations" means that the load transfer locations are formed relative to each other so that a space or clearance is formed between the portion of the anvil mounting portion **2010** extending between the load transfer locations and the inner surface **3076** of the end effector closure tube **3050**.

For example, a first amount of clearance CR_1 is formed between the inner surface **3076** of the end effector closure tube **3050** extending between the first right load transfer location **2070**R and the second right load transfer location **2072**R. A second amount of clearance CR_2 is formed between the inner surface of the end effector closure tube **3050** extending between the third right load transfer location **2072**R and the third right load transfer location **2074**R. A third amount of clearance CR_3 is formed between the third right load transfer location **2074**R and the fourth right load transfer location **2076**R. A first amount of clearance CL_1 is formed between the inner surface of the end effector closure tube extending between the first left load transfer location **2070**L and the second left load transfer location **2072**L. A second amount of clearance CL_2 is formed between the inner surface **3076** of the end effector closure tube extending between the second left load transfer location **2072**L and the third left load transfer location **2074**L. A third amount of clearance CL_3 is formed between the third left load transfer location **2074**L and the fourth left load transfer location **2076**L. In at least one arrangement, the closure forces CF applied to the closure cam surfaces **2020**, as well as the proximal portion **2032** of the anvil cap **2030** may be evenly distributed between the first right load transfer location **2070**R and the first left load transfer location **2070**L. Likewise, the closure forces CF applied to the elongate channel **1310** may be evenly distributed between the fourth right load transfer location **2076**R and the fourth left load transfer location **2076**L, for example.

In at least one arrangement, at least two right load transfer locations **2070**R, **2072**R and at least two left load transfer locations **2070**L, **2072**L are located on one side of a horizontal plane HP that bisects the end effector **1300**. As illustrated in FIG. **13**, the two right load transfer locations **2070**R, **2072**R are located on an opposite side of vertical plane VP from the two left load transfer locations **2070**L, **2072**L. Also in at least one arrangement, the third right load transfer location **2074**R and the fourth right load transfer location **2076**R are located on an opposite side of the horizontal plane HP from the first right load transfer location **2070**R and the second right load transfer location **2072**R. Similarly, third left load transfer location **2074**L and the fourth left load transfer location **2076**L are located on a opposite side of the horizontal plane HP from the first left load transfer location **2070**L and the second left load transfer location **2072**L. The right load transfer locations **2074**R, **2076**R are located on an opposite side of vertical plane VP from the two left load transfer locations **2074**L, **2076**L. As can be seen in FIGS. **6** and **10**, the load transfer locations may be formed by scalloped or relieved areas **2080**, **2082**, **2084** so that the load transfer locations comprise corners formed from adjoining surfaces. Other load transfer location shapes are contemplated.

FIGS. **14** and **15** illustrate the anvil **2000** and the end effector closure tube **3050** in an "over-closed" state that is created as the end effector closure tube **3050** is advanced further distally after the anvil **2000** has attained the closed position. In at least one example, the anvil **2000** is in an "over-closed state" when a distal end portion **2003** of the body portion **2002** of the anvil **2000** is in contact with the cartridge deck of the staple cartridge that is operably supported with the elongate channel **1310**. See FIG. **14**. Continued distal advancement of the end effector closure tube **3050** after the anvil **2000** has attained the closed position may significantly increase the hoop stress formed in the end effector closure tube **3050** which may cause the end effector closure tube to effectually fail or vertically elongate which can detrimentally effect the proper closure of the anvil when used in future applications. As be seen in FIG. **15**, the first right amount of clearance CR_1 and the first left amount of clearance CL_1 may each have a clearance width CW_1 that is located on a common side of the horizontal plane HP. The second right amount of clearance CR_2, and the second left amount of clearance CL_2 each span across the horizontal plane HP. Stated another way, portions of the second right

amount of clearance CR_2 are located on each side of the horizontal plane HP and portions of the second left amount of clearance CL_2 are located on each side of the horizontal plane HP.

Forming at least two discrete load transfer locations located on each side of the vertical plane may reduce the amount of detrimental hoop stresses established in the end effector closure tube **3050** as it is distally moved into the over-closed position. By forming at least three load transfer locations located on each side of the vertical plane may further reduce the amount of detrimental hoop stresses established in the end effector closure tube **3050** as it is distally moved into the over-closed position. Forming at least four load transfer locations located on each side of the vertical plane may further reduce the amount of detrimental hoop stresses established in the end effector closure tube **3050** as it is distally moved into the over-closed position. Such arrangements therefor enable the end effector closure tube **3050** to be made with a constant wall thickness as described above, which may reduce the amount of manufacturing costs associated with manufacturing the end effector closure tube.

FIGS. **16-22** illustrate an alternative anvil **2000'** that is substantially identical to anvil **2000** described above expect for the differences discussed below. As can be seen in FIG. **16**, the anvil mounting portion **2010'** is formed with continuous arcuate anvil camming surfaces **2020'** that are not interrupted by any load transfer locations. FIGS. **17** and **18** illustrate the anvil **2000'** in a fully open position. As can be seen in FIG. **17**, the end effector closure tube **3050'** is in its proximal most position when the "second jaw" or anvil **2000'** is in its fully open position. When in that position, the end effector closure tube **3050'** is not applying any closure forces to the cam closure surfaces **2020'**.

FIG. **23** illustrates one form of an end effector closure tube **3050'** that may be identical to the end effector closure tube **3050** described above, except for the differences noted below. The end effector closure tube **3050'** comprises an external surface **3074'** and an internal wall surface **3076'**. In at least one form, the closure tube **3050'** has a constant wall thickness WT_1 except for a segment A_s of the wall located at the top of the end effector closure tube **3050'** that has a thicker wall thickness WT_2 that is greater than WT_1. Such arrangement forms a single load transfer location **2070'**.

FIGS. **19** and **20** illustrate the positions of the end effector closure tube **3050'** and the anvil **2000'** when the anvil **2000'** is in the closed position. As can be seen in FIG. **20**, as the end effector closure tube **3050'** is moved distally, the load transfer location **2070'** on the end effector closure tube **3050'** contacts the cam surface **2034** on the proximal portion **2032** of the anvil cap **2030**. The end effector closure tube **3050'** also contacts portions of the elongate channel **1310** on each side of the vertical plane VP that bisects the end effector. The load transfer location **2070'** may span across the entire cam surface **2034** to contact an upper portion of the cam surfaces **2020'** on each side of the vertical plane VP as shown in FIG. **20**. When in the closed position shown in FIGS. **19** and **20**, such arrangement serves to form a space **3077** between the corresponding portions of the inner surface **3076'** of the end effector closure tube **3050'** and the cam surfaces **2020'** of the anvil mounting portion **2010'** as shown in FIG. **20**. The spaces **3077** each extend from the load transfer location **2070'** and the area wherein the inner surface **3076'** contacts the elongate channel **1310** (space distance S_D). Thus, when the anvil **2000'** is moved to a closed position, there is a discrete first load transfer location **2070'** located on one side of a horizontal plane HP and two discrete load transfer locations **2072**R', **2072**L' locations located on an opposite side of the horizontal plane HP. The discrete first load transfer location **2070'** is separated from each of the discrete load transfer locations **2072**R', **2072**L' by spaces **3077** when the anvil **2000'** is in the closed position. See FIG. **20**. As can also be seen in FIG. **20**, the load transfer locations **2072**R', **2072**L' are located on opposite sides of the vertical plane VP.

FIGS. **21** and **22** illustrate the interrelationship between the end effector closure tube **3050'** and the anvil **2000'** when the end effector closure tube **3050'** has moved the anvil **2000'** in an over-closed orientation. As can be seen in FIG. **22**, when in the over-closed position, the end effector closure tube **3050'** contacts the anvil **2000'** and the elongate channel **1310** to form a discrete load transfer location **2070'** that is separated from discrete load transfer locations **2074**R', **2074**L' by spaces **3079**R, **3079**L. The discrete load transfer location **2074**R' is separated by the discrete load transfer location **2076**R' by a space **3081**R and the discrete load transfer location **2074**L' is separated from a discrete load transfer location **2076**L' by a space **3081**L. Thus, in this arrangement, at least one discrete load transfer location (**2070'**) spans a vertical plane VP that bisects the end effector and at least two discrete load transfer locations span a horizontal plane HP that bisects the end effector. In addition, at least one discrete load transfer location is located on each side of the horizontal plane HP and at least one discrete load transfer location is located on each side of the vertical plane VP. Such arrangement of load transfer locations in the above manner may help to prevent the vertical elongation of the end effector closure tube **3050'**.

FIGS. **24-30** illustrate an alternative anvil **2000"** that is substantially identical to anvil **2000** described above expect for the differences discussed below. As can be seen in FIG. **24**, the anvil mounting portion **2010"** is formed with an arcuate anvil camming surface **2020"** and right and left notched or recessed portions **2022"**. FIGS. **24** and **25** illustrate the anvil **2000"** in a fully open position. As can be seen in FIG. **24**, the end effector closure tube **3050"** is in its proximal most position when the "second jaw" or anvil **2000"** is in its fully open position. When in that position, the end effector closure tube **3050"** is not applying any closure forces to the cam closure surfaces **2020"**. FIG. **30** illustrates one form of an end effector closure tube **3050"** that may be identical to the end effector closure tube **3050** described above, except for the differences noted below. The end effector closure tube **3050"** comprises an external surface **3074"** and an internal wall surface **3076"**. In at least one form, the closure tube **3050"** has a first wall thickness WT_1, a second wall thickness WT_2, a third wall thickness WT_3, and a fourth wall thickness WT_4 that are arranged as shown in FIG. **30**. In at least one arrangement, for example, $WT_1<WT_2<WT_3\leq WT_4$. In some cases, $WT_3>WT_4$. The portion of the end effector closure tube **3050"** that has a wall thickness corresponding to WT_4 forms a load transfer location **2070"**. In the illustrated arrangement, for example, the load transfer location **2070"** spans across a vertical plane VP that bisects the end effector closure tube **3050"**. The portions of the end effector closure tube **3050"** that have a wall thickness WT_3 form load transfer locations **2072**R", **2072**L". In at least one arrangement as shown in FIG. **30**, the load transfer locations **2072**R", **2072**L" span across a horizontal plane HP that bisects the end effector closure tube **3050"**.

Referring now to FIGS. **26** and **27**, as the end effector closure tube **3050"** is moved distally, the load transfer location **2070"** contacts the cam surface **2034** on the proximal portion **2032** of the anvil cap **2030**. The load transfer locations **2072**R", **2072**L" also contact corresponding por-

tions of the anvil mounting portion **2010"**. Also portions of the end effector closure tube **3050"** form load transfer locations **2074**R", **2074**L" that contact corresponding portions of the elongate channel **1310** to move the anvil **2000"** to the closed position shown in FIGS. **26** and **27**. When in the closed position shown in FIGS. **26** and **27**, such arrangement serves to form a space **3077"**, **3079"** between the corresponding portions of the inner surface **3076"** of the end effector closure tube **3050"** and the cam surfaces **2020"** of the anvil mounting portion **2010"** as shown in FIG. **27**. The spaces **3077"** are located between the load transfer location **2070"** and the load transfer locations **2072**R", **2072**L". The spaces **3079"** are located between the load transfer locations **2072**R", **2072**L" and the load transfer locations **2074**R, **2074**L" as shown in FIG. **27**.

FIGS. **28** and **29** illustrate the interrelationship between the end effector closure tube **3050"** and the anvil **2000"** when the end effector closure tube **3050"** has moved the anvil **2000"** into an over-closed orientation. As can be seen in FIG. **29**, in addition to the load transfer locations **2070"**, **2072**R", **2072**L", **2074**R", **2074**L", discrete load transfer locations **2076**R", **2076**L" are formed by the edge of the recessed portions **2022"** formed on the anvil mounting portion **2010"**. Such discrete load transfer locations **2076**R", **2076**L" are separated from the corresponding discrete load transfer locations **2072**R". **2072**L" by corresponding spaces **3081"**. The provision of the discrete load transfer locations in the above manner may help to prevent the vertical elongation of the end effector closure tube **3050"**.

When using an end effector **1300** of the type and construction described herein, a clinician manipulates the first and second jaws (the anvil **2000** and the elongate channel **1310** that has a surgical staple cartridge operably mounted therein), to capture the tissue to be cut and stapled (the "target tissue") therebetween. As can be seen in FIGS. **5** and **7**, for example, a surgical staple cartridge **4000** comprises a cartridge body **4010** that is configured to be removably supported within the elongate channel **1310**. The cartridge body **4010** includes an elongate cartridge slot **4016** that extends from a proximal end **4012** through the cartridge body **4010** to a distal end portion **4014** to enable the knife member or firing member **1920** to pass therethrough. The cartridge body **4010** further defines a cartridge deck surface **4020** on each side of the elongate slot **4016**. A plurality of staple cavities **4022** are provided in the cartridge body **4010** on each side of the elongate slot **4016**. Each cavity **4022** opens through the deck surface **4020** to removably support a surgical staple or staples therein. In at least one cartridge arrangement, three lines of staple cavities **4022** are provided on each side of the elongate slot **4016**. The lines are formed such that the staples in a center line are staggered relative to the staples in the two adjacent outer lines. The staples are supported on staple drivers that are movably supported within each staple cavity. In at least some arrangements, the staple drivers are arranged to be contacted or "fired" upward when contacted by a cam member or camming portions associated with the knife member **1920**, for example. In some arrangements, a wedge sled or camming sled is movably supported in the cartridge body and is adapted to be axially displaced through the cartridge body as the knife member **1920** is axially deployed through the cartridge from the proximal end portion **4012** to the distal end portion **4014** of the cartridge body **4010**. The wedge sled includes a camming member or wedge associated with each line of staple cavities so as to serially deploy the staple drivers supported therein. As the cam contacts a staple driver, the driver is driven upwardly within the staple cavity driving the staple or staples supported thereon out of the staple cavity through the clamped tissue and into forming contact with the staple-forming undersurface of the anvil. The wedge sled or camming member is located distal to the knife or tissue cutting edge of the knife or firing member **1920**, so that the tissue is stapled prior to be severed by the tissue cutting edge.

When the clinician initially locates the target tissue between the anvil and the staple cartridge, it is important that the target tissue be located so that the knife does not cut into the target tissue unless it is first stapled. In previous anvil arrangements, tissue stops are provided on the proximal end of the anvil body to prevent the target tissue from moving proximally past the proximal most staple pockets in the staple cartridge. Such tissue stops form abrupt proximal ends that confront or face the distal end of the end effector closure tube. As the closure tube is moved distally to close the anvil, tissue extending outward from between the anvil and the cartridge occasionally will become undesirably pinned or pinched between the proximal ends of the tissue stops and the distal end of the end effector closure tube. The examples disclosed below are configured to minimize the possibility of tissue being pinched between the tissue stops and the end effector closure tube when the anvil is being moved to the closed and over-closed positions in the various manners described herein.

Turning to FIG. **7**, for example, the staple cartridge **4000** includes staples (not shown) that are removably supported or stored in each of the proximal most staple cavities **4022**P located in the lines of staple cavities **4022** located in the cartridge body **4010** on each side of the elongate slot **4016**.

In various circumstances, to prevent the target tissue from being clamped proximal to the staples in the proximal most staple cavities **4022**P, the anvil **2000** includes two tissue stop members **2040** that protrude downwardly past the staple-forming undersurface on each side of the anvil body. When the anvil is in a closed position or in an over-closed position, each of the tissue stop members **2040** protrude downwardly on each side of the cartridge body **4010**. FIG. **7** illustrates the anvil **2000** in an open configuration. As can be seen in that Figure, each of the tissue stops **2040** extend below the cartridge deck surface to prevent the target tissue from extending proximally past the staples in the proximal most staple cavities **4022**P. As can be seen in FIGS. **7**, **31** and **32**, in at least one arrangement, the tissue stops **2040** are integrally formed with the anvil body portion **2002**. The anvil body portion **2002** and the proximal ends of the tissue stops **2040** extend slightly above the corresponding camming surfaces **2020** formed on the anvil mounting portion **2010**. In the illustrated example, the proximal ends of the tissue stops **2040** are segmented into an upper proximal end portion **2042**, a lower proximal end portion **2043** and a bottom proximal end portion **2044**. See FIGS. **31** and **32**. As can also be seen in FIGS. **31** and **32**, an angled surface or chamfer surface **2045** is formed between the upper proximal end portion **2042** and the camming surface **2020** on the anvil mounting portion. An angled surface or chamfer surface **2046** is formed between the lower proximal end portion **2043** and the camming surface **2020** and an angled surface or chamfer surface **2047** is formed between the bottom proximal end portion **2044** and the camming surface **2020**. In the illustrated arrangement wherein scalloped or relieved areas **2080**, **2082**, **2084** are formed in the anvil mounting portion **2010**, the chamfer **2045** corresponds to the relieved area **2080**. See FIG. **33**. The lower proximal end portion **2043** and accompanying chamfer **2046** correspond to

relieved area **2082** and the bottom proximal end portion **2044** and accompanying chamfer **2047** corresponds to relieved area **2084**.

As discussed above, the anvil **2000** is moved from a fully open position to the closed position and an over-closed position by the axially movable end effector closure tube **3050**. FIGS. **31** and **33** illustrate the position of the end effector closure tube **3050** relative to the tissue stops **2040** when the anvil **2000** is in the closed position. As can be seen in FIG. **33**, the upper proximal end portion **2042** and accompanying chamfer **2045** are approximately parallel to a corresponding portion of a distal end **3051** of the end effector closure tube **3050**. To reduce a possibility of tissue being inadvertently pinched between the tissue stops **2040** and the distal end **3051** of the end effector closure tube **3050**, the lower proximal end portion **2043** and the bottom proximal end portion **2044** of the tissue stop **2040** and the corresponding chamfers **2046** and **2047** angle away from the distal end **3051** of the end effector closure tube **3050**. This arrangement has the practical effect of increasing a distance between the portion of the tissue stop and the end effector closure tube that may most likely encounter adjacent tissue.

FIG. **33** is an enlarged view of a portion of the end effector depicted in FIG. **31** wherein the anvil **2000** is in a closed position. When in that position, the upper proximal end portion **2042** of each tissue stops **2040** is located a first tissue distance TD_1 from the distal end **3051** of the end effector closure tube **3050**. The bottom proximal end portion **2044** of each tissue stop **2040** is located a second tissue distance TD_2 from the distal end **3051** of the end effector closure tube **3050**. As can be seen in that Figure, $TD_2 > TD_1$. FIGS. **32** and **34** depict the anvil **2000** in an over-closed position. The first tissue distance TD_1' between the upper proximal end portion **2042** of each tissue stop **2040** is still slightly less than the second tissue distance TD_2' between the bottom proximal end portion **2044** of each tissue stop **2040** and the distal end **3051** of the end effector closure tube **3050** which will still reduce the likelihood of tissue pinch therebetween. Also, the inclusion of the chamfered surfaces **2045**, **2046** and **2047** may help to lessen the likelihood of pinching tissue between the tissue stops **2040** and the distal end **3051** of the end effector closure tube **3050** when the anvil **200** is moved to the closed and over-closed positions. In at least one example, TD_2 and/or TD_2' may be approximately ten thousands of an inch to approximately twenty-five thousands of an inch. However, other gaps may be attained. The person of ordinary skill in the art will appreciate that the above-described tissue stop configurations will also work with other forms of end effector closure tube and closure member arrangements.

FIGS. **35-38** illustrate another anvil embodiment **5000** that is identical to anvil **2000** described above except for the differences relating to tissue stops **5040**. Tissue stops **5040** may be identical to tissue stops **2040** except that proximal end portions **5042**, **5043**, **5044** of each tissue stop and the accompanying chamfer surfaces **5045**, **5046**, **5047** are approximately parallel to the distal end **5031** of the end effector closure tube **5030**. End effector closure tube **5050** may otherwise be identical to end effector closure tube **3050** described above, except for the differences discussed below. FIGS. **35** and **36** illustrate the anvil **5000** in the closed position. In this arrangement, an area that may otherwise be susceptible to pinching tissue is the edge of the bottom proximal end portion **5044** and the confronting portion of the distal end **5031** of the end effector closure tube **5050**. To alleviate and minimize such possibility, a relieved area **5060** is formed in the distal end **5031** of the end effector closure tube **5030** that confronts or, stated another way, is opposite from the bottom proximal end **5044** of each of the tissue stops **5040**. In the illustrated example, each relieved area **5060** comprises an arcuate notch **5062** that is formed in the portion of the distal end **5031** of the end effector closure tube **5030** corresponding to the bottom proximal end portion **5044** of each tissue stop **5040**. In the illustrated arrangements, for example, the bottom proximal end portion **5044** of each of the tissue stops **5040** terminates in a bottom corner **5070** and the apex or bottom **5064** is directly across from the bottom corner **5070** when the end effector closure tube **5050** is in the position corresponding to the closed position of the anvil **5000**. Other notch shapes, however, may be employed.

FIG. **36** is an enlarged view of a portion of the end effector depicted in FIG. **35** wherein the anvil **5000** is in a closed position. When in that position, the upper proximal end portion **5042**, the lower proximal end portion **5043** and the bottom proximal end portion **5044** of each tissue stop **5040** are located a first tissue distance TD_1 from the distal end **3051** of the end effector closure tube **5050**. The bottom proximal end portion **5044** of each tissue stop **5040** is located a second tissue distance TD_2 from the apex or bottom **5064** of the notch **5062** in the distal end **5051** of the end effector closure tube **5050**. As can be seen in that Figure, $TD_2 > TD_1$. FIGS. **37** and **38** depict the anvil **5000** in an over-closed position. The first tissue distance TD_1' between the bottom proximal end portion **5044** of each tissue stop **5040** is still less than the second tissue distance TD_2' between the bottom proximal end portion **5044** of each tissue stop **2040** and the apex **5064** of the corresponding notch **5062** in the distal end **5051** of the end effector closure tube **5050** which will still reduce the likelihood of tissue pinch therebetween. Also, the inclusion of the chamfered surfaces **5045**, **5046** and **5047** may help to lessen the likelihood of pinching tissue between the tissue stops **5040** and the distal end **5051** of the end effector closure tube **5050** when the anvil **5000** is moved to the closed and over-closed positions. The person of ordinary skill in the art will appreciate that the above-described tissue stop configurations will also work with other forms of end effector closure tube and closure member arrangements.

FIG. **39** illustrates a previous surgical staple cartridge **4000** that includes a cartridge body **4010** that is configured to be removably supported within the elongate channel **1310**. The cartridge body **4010** includes an elongate cartridge slot **4016** that extends from a proximal end **4012** through the cartridge body **4010** to a distal end portion **4014** to enable the knife member or firing member **1920** (FIG. **5**) to pass therethrough. The cartridge body **4010** further defines a cartridge deck surface **4020** on each side of the elongate slot **4016**. See FIG. **39**. A plurality of staple cavities **4022** are provided in the cartridge body **4010** on each side of the elongate slot **4016**. Each cavity **4022** opens through the deck surface **4020** to removably support a surgical staple or staples therein. In at least one cartridge arrangement, three lines of staple cavities **4022** are provided on each side of the elongate slot **4016**. In the illustrated example, the lines are formed such that the staples in a center line are staggered relative to the staples in the two adjacent outer lines. The staples are supported on staple drivers that are movably supported within each staple cavity. In at least some arrangements, the staple drivers are arranged to be contacted or "fired" upward when contacted by a cam member or camming portions associated with the knife member **1920**, for example. In some arrangements, a "wedge" sled or camming sled is movably supported in the cartridge body **4010** and is adapted to be axially displaced through the cartridge body

4010 as the knife member 1920 is axially deployed through the cartridge from the proximal end portion 4012 to the distal end portion 4014 of the cartridge body 4010. The wedge sled includes a camming member or "wedge" associated with each line of staple cavities so as to serially deploy the staple drivers supported therein. As the corresponding wedge or cam contacts a staple driver, the driver is driven upwardly within the staple cavity thereby driving the staple or staples supported thereon out of the staple cavity through the clamped tissue and into forming contact with the staple-forming undersurface of a confronting anvil of the end effector. The wedge sled or camming member is located distal to the knife or tissue cutting edge of the knife or firing member 1920, so that the tissue is stapled prior to being severed by the tissue cutting edge on the knife or firing member.

Variations to the arrangement and/or geometry of staples in a staple line can affect the flexibility and sealing properties of the staple line. For example, a staple line comprised of linear aligned staples can provide a limited amount of flexibility or stretch because the staple line can flex or stretch between the linear staples. Consequently, a limited portion of the staple line (e.g., the portion between staples) is flexible. A staple line comprised of angularly-oriented staples can also flex or stretch between the staples. However, the angularly-oriented staples are also able to rotate, which provides an additional degree of stretch within the staple line. A staple line comprised of angularly-oriented staples may be capable of stretching in excess of 60%, for example. In certain instances, a staple line comprised of angularly-oriented staples can stretch at least 25% or at least 50%, for example. The arrangement of staples includes the relative orientation of the staples and the spacing between the staples, for example. The geometry of the staples includes the size and shape of the staples, for example. The flexibility and sealing properties of a staple line can change at longitudinal and/or lateral positions based on the arrangement and/or geometry of the staples. In certain instances, it is desirable to alter the flexibility and/or sealing properties of a staple line at one or more locations along the staple line. For example, it can be desirable to maximize the flexibility of the staple line or a portion thereof. Additionally or alternatively, it can be desirable to minimize the flexibility of the staple line or a portion thereof. It can also be desirable to maximize the sealing properties of the staple line or a portion thereof. Additionally or alternatively, it can be desirable to minimize the sealing properties of the staple line or a portion thereof.

The arrangement of staple cavities in a staple cartridge corresponds to the arrangement of staples in a staple line generated by the staple cartridge. For example, the spacing and relative orientation of staple cavities in a staple cartridge corresponds to the spacing and relative orientation of staples in a staple line generated by the staple cartridge. In various instances, a staple cartridge can include an arrangement of staples cavities that is selected and/or designed to optimize the flexibility and/or sealing properties of the resultant staple line. A surgeon may select a staple cartridge having a particular arrangement of staple cavities based on the surgical procedure to be performed and/or the properties of the tissue to be treated during the surgical procedure, for example.

In certain instances, it can be desirable to generate a staple line with different staple patterns. A staple line can include a first pattern of staples for a first portion thereof and a second pattern of staples for a second portion thereof. The first pattern and the second pattern can be longitudinally offset. For example, the first pattern can be positioned at the proximal or distal end of the staple line. In other instances, the first pattern and the second pattern can be laterally offset and, in still other instances, the first pattern and the second pattern can be laterally offset and longitudinally offset. A staple line can include at least two different patterns of staples.

In certain instances, the majority of staples in a staple line can form a major pattern and other staples in the staple line can form one or more minor patterns. The major pattern can span a significant portion of the staple line and can include a longitudinally-repetitive sub-pattern. In certain instances, the minor pattern, or irregularity, can deviate from the major pattern. The minor pattern can be an anomaly at one or more locations along the length of the staple line, for example. The different patterns in a staple line can be configured to produce different properties at predefined locations. For example, the major pattern can be a highly flexible or elastic pattern, which can permit extensive stretching of the stapled tissue, and the minor pattern can be less flexible or less elastic. It can be desirable for the majority of the staple line to be highly flexible and for one or more limited portions to be less flexible, for example. In other instances, the minor pattern can be more flexible than the major pattern. In certain instances, because the minor pattern extends along a shorter portion of the staple line, the flexibility of the minor pattern may not impact, or may not significantly impact, the overall flexibility of the entire staple line. U.S. patent application Ser. No. 15/385,389, entitled STAPLE CARTRIDGE AND ARRANGEMENTS OF STAPLES AND STAPLE CAVITIES THEREIN, now U.S. Patent Application Publication No. 2018/0168629, the entire disclosure of which is hereby incorporated by reference herein discloses various staple cartridge and staple driver arrangements. U.S. Pat. No. 9,801,627, entitled FASTENER CARTRIDGE FOR CREATING FLEXIBLE STAPLE LINES, the entire disclosure of which is hereby incorporated by reference herein discloses various cartridge an anvil arrangements for creating flexible lines of surgical staples.

Referring again to FIG. 39, the majority of the staple cavities 4022 in the cartridge 4000 are arranged in a first pattern, or major pattern, 4030. The first pattern 4030 is a longitudinally-repetitive pattern of angularly-oriented staple cavities 4022. Longitudinally-repetitive patterns are patterns in which a sub-pattern or arrangement is longitudinally repeated. For example, an arrangement of three staple cavities on each side of the slot 4016 (an inner staple cavity, an intermediate staple cavity, and an outer staple cavity) can be repeated along at least a portion of the length of the staple cartridge body 4010. Various longitudinally-repetitive patterns of angularly-oriented staples cavities are described in U.S. patent application Ser. No. 14/498,145, filed Sep. 26, 2014, now U.S. Patent Application Publication No. 2016/0089142, entitled METHOD FOR CREATING A FLEXIBLE STAPLE LINE, which is hereby incorporated by reference herein in its entirety. The openings 4024 of the staple cavities 4022 in the first pattern 4030 form a herringbone pattern having six rows of angularly-oriented staple cavity openings 4024 in the cartridge deck surface 4020. An inner row 4026*a*, an intermediate row 4026*b*, and an outer row 4026*c* of staple cavities 4022 are positioned on each side of the slot 4016.

Each staple cavity opening 4024 has a proximal end 4027 and a distal end 4028. The proximal end 4027 and the distal end 4028 of the staple cavities 4022 in the first pattern 4030 are laterally offset. Stated differently, each staple cavity 4022 in the first pattern 4030 is angularly oriented relative to a

longitudinal staple cartridge axis SCA. A cavity axis CA extends between the proximal end **4027** and the distal end **4028** of each opening **4024**. The cavity axes CA are obliquely oriented relative to the slot **4016**. More specifically, the openings **4024** in the inner rows **4026***a* of staple cavities **4022** and the outer rows **4026***c* of staple cavities **4022** are oriented at 45 degrees, or about 45 degrees, relative to the longitudinal staple cartridge axis SCA, and the openings **4024** in the intermediate rows **4026***b* of staple cavities **4022** are oriented at 90 degrees, or about 90 degrees, relative to the openings **4024** of the inner rows **4026***a* and the outer rows **4026***c*.

In the example of FIG. **39**, certain staple cavities in the cartridge body **4010** are oriented at an angle that is anomalous or irregular with respect to the staple cavities **4022** in the first pattern **4030**. More specifically, the angular orientation of proximal staple cavities **4022***a*, **4022***b*, **4022***c*, and **4022***d* and distal staples cavities **4022***e*, **4022***f*, **4022***g*, and **4022***h* does not conform to the herringbone arrangement of the staple cavities **4022** in the first pattern **4030**. Rather, the proximal staple cavities **4022***a*-**4022***d* and the distal staple cavities **4022***e*-**4022***h* are angularly offset from the staple cavities **4022** in the first pattern **4030**. The proximal staple cavities **4022***a*, **4022***b*, **4022***c*, and **4022***d* are obliquely oriented relative to the staples cavities **4022** in the first pattern **4030**, and the distal staple cavities **4022***e*, **4022***f*, **4022***g*, and **4022***h* are also obliquely oriented relative to the staples cavities **4022** in the first pattern **4030**. The proximal and distal staple cavities **4022***a*-**4022***h* are oriented parallel to the slot **4016** and to the longitudinal staple cartridge axis SCA.

The proximal staple cavities **4022***a*-**4022***d* form a proximal pattern **4040** that is distinct from the first pattern **4030**, and the distal staple cavities **4022***e*-**4022***h* form a distal pattern **4042** that is also distinct from the first pattern **4030**. In the depicted arrangement, the proximal pattern **4040** includes a first pair of parallel, longitudinally-aligned staple cavities **4022***a*, **4022***b* on a first side of the slot **4016** and a second pair of parallel, longitudinally-aligned staple cavities **4022***c*, **4022***d* on a second side of the longitudinal slot **4016**. The distal pattern **4042** also includes a first pair of parallel, longitudinally-aligned staple cavities **4022***e*, **4022***f* on the first side of the longitudinal slot **4016** and a second pair of parallel, longitudinally-aligned staple cavities **4022***g*, **4022***h* on the second side of the longitudinal slot **4016**. In other instances, the distal pattern **4042** can be different from the proximal pattern **4040**.

The proximal pattern **4040** and the distal pattern **4042** are symmetric relative to the longitudinal staple cartridge axis SCA. In other instances, the proximal pattern **4040** and/or the distal pattern **4042** can be asymmetric relative to the longitudinal staple cartridge axis SCA. For example, the staple cavities **4022***e* and **4022***f* can be longitudinally offset from the staple cavities **4022***g* and **4022***h* and/or the staple cavities **4022***a* and **4022***b* can be longitudinally offset from the staple cavities **4022***c* and **4022***d*. Additionally or alternatively, in certain instances, the staple cartridge body **4010** can include either the proximal pattern **4040** or the distal pattern **4042**. In other instances, the staple cavities **4022** defined in the staple cartridge body **4010** can include additional and/or different patterns of staple cavities **4022**.

As can be further seen in FIG. **39**, atraumatic extenders **4050** extend or protrude from the deck surface **4020** around a portion of the staple cavities **4022** in the first pattern **4030**. The atraumatic extenders **4050** surround the proximal and distal ends **4027** and **4028**, respectively, of the openings **4024** of the staple cavities **4022** in the first pattern **4030**. The atraumatic extenders **4050** may be configured to grip tissue that is clamped by the end effector. Additionally or alternatively, in certain instances, the tips of the staple legs can protrude from the cartridge body **4010**. In such instances, the atraumatic extenders **4050** may be configured to extend flush with and/or beyond the tips of the staple legs to prevent the tips from prematurely penetrating tissue. Consequently, larger staples, e.g., staples having longer legs, can be positioned in the staple cavities **4022** having atraumatic extenders **4050** positioned therearound. For example, referring again to FIG. **39**, larger staples can be positioned in the staple cavities **4022** in the first pattern **4030** than the staples in the staple cavities in the proximal pattern **4040** and the distal pattern **4042** without risking premature piercing of tissue by the longer staple legs. In certain instances, atraumatic extenders **4050** can be positioned around staples cavities **4022** in the proximal pattern **4040** and/or the distal pattern **4042**, and larger staples can be positioned in one of more of those staple cavities **4022***a*-**4022***h*, as well.

The staple cartridge body **4010** can be configured to generate a staple line having different properties along the length thereof. A staple line **4060** generated by the staple cartridge body **4010** and embedded in tissue T is depicted in FIG. **40**. The staple line **4060** is comprised of staples **4062**, and an exemplary staple **4062** for use with various staple cartridges described herein is depicted in FIG. **41**. The staple **4062** can be comprised of a bent wire, for example. The wire can have a diameter of 0.0079 inches, or approximately 0.0079 inches. In other instances, the wire can have a diameter of 0.0089 inches, or approximately 0.0089 inches. In still other instances, the wire can have a diameter of 0.0094, or approximately 0.0094 inches. In certain instances, the wire can have a diameter of less than 0.0079 inches or more than 0.0094 inches. The reader will appreciate that the diameter of the wire can dictate the diameter of the staple. The staple **4062** is a substantially U-shaped staple having a base **4064**, a first leg **4066** extending from a first end of the base **4064**, and a second leg **4068** extending from a second end of the base **4064**. The first leg **4066** is substantially parallel to the second leg **4068** and substantially perpendicular to the base **4064**. When implanted in tissue T, the angular orientation of the base **4064** corresponds to the angular orientation of the staple cavity opening **4024** from which the staple **4062** was fired.

Another exemplary staple **4070** that may be used with various staple cartridges described herein is depicted in FIG. **42**. The staple **4070** is a substantially "V-shaped" staple having a base **4072**, a first leg **4074** extending from a first end of the base **4072**, and a second leg **4076** extending from a second end of the base **4072**. The first leg **4074** is obliquely oriented relative to the second leg **4076** and the base **4072**. When implanted in tissue T, the orientation of the base **4072** corresponds to the orientation of the staple cavity opening **4024** from which the staple **4070** was fired. The reader will appreciate that staples having different geometries can also be fired from the staple cartridges described herein.

Referring again to FIG. **40**, the staple line **4060** includes a first portion **4061**, a proximal portion **4063**, and a distal portion **4065**. The first portion **4061** is generated from the first pattern, or major pattern, **4030** and extends along a substantial portion of the staple line **4030**. Owing to the angular orientation of the staples **4062** in the first portion **4030**, the first portion **4061** is substantially flexible or compliant. For example, because the angularly-oriented staples **4062** can rotate within the stapled tissue T while minimizing trauma to the tissue T, the first portion **4061** is

configured to stretch or extend longitudinally and/or laterally as the stapled tissue stretches.

The proximal portion **4063** is generated from the proximal pattern **4040** and forms the proximal end of the staple line **4060**. The distal portion **4065** is generated from the distal pattern **4042** and forms the distal end of the staple line **4060**. Owing to the parallel orientation of the staples **4062** in the proximal portion **4063** and the distal portion **4065** of the staple line **4060**, the proximal portion **4063** and the distal portion **4065** of the staple line **4060** can be less flexible than the first portion **4061**. However, the reduced flexibility of the proximal portion **4063** and the distal portion **4065** may not impact, or not substantially impact, the overall flexibility of the staple line **4060**. Moreover, as described herein, the proximal portion **4063** and the distal portion **4065** may not extend adjacent to the cutline and, in certain instances, the proximal portion **4063** may be absent or missing from the staple line **4060**.

As described herein, staples are removably positioned in a staple cartridge and fired from the staple cartridge during use. In various instances, the staples can be driven out of staple cavities in the staple cartridge and into forming contact with an anvil. For example, a firing element can translate through the staple cartridge during a firing stroke to drive the staples from the staple cartridge toward an anvil. In certain instances, the staples can be supported by staple drivers and the firing element can lift the staple drivers to eject or remove the staples from the staple cartridge.

An anvil can include a staple-forming undersurface having staple-forming pockets defined therein. In certain instances, the staple-forming pockets can be stamped in the anvil. For example, the staple-forming pockets can be coined in a flat surface of the anvil. The reader will appreciate that certain features of the staple-forming pockets can be a deliberate consequence of a coining process. For example, a certain degree of rounding at corners and/or edges of the staple-forming produce can be an intentional result of the coining process. Such features can also be designed to better form the staples to their formed configurations, including staples that become skewed and/or otherwise misaligned during deployment.

Each staple in the staple cartridge can be aligned with a staple-forming pocket of the anvil. In other words, the arrangement of staple cavities and staples in a staple cartridge for an end effector can correspond or match the arrangement of staple-forming pockets in an anvil of the end effector. More specifically, the angular orientation of each staple cavity can match the angular orientation of the respective staple-forming pocket. For example, when the staple cavities are arranged in a herringbone pattern, the staple-forming pockets can also be arranged in a herringbone pattern.

When staples are driven from the staple cartridge and into forming contact with the anvil, the staples can be formed into a "fired" configuration. In various instances, the fired configuration can be a "B-form" configuration, in which the tips of the staple legs are bent toward the staple base or crown to form a capital letter B having symmetrical upper and lower loops. In other instances, the fired configuration can be a modified B-form, such as a skewed B-form configuration, in which at least a portion of a staple leg torques out of plane with the staple base, or an asymmetrical B-form configuration, in which the upper and lower loops of the capital letter B are asymmetric. Tissue can be captured or clamped within the formed staple.

The arrangement of staples and/or staple cavities in a staple cartridge can be configured to optimize the corresponding arrangement of staple-forming pockets in the forming surface of a complementary anvil. For example, the angular orientation and spacing of staples in a staple cartridge can be designed to optimize the forming surface of an anvil. In certain instances, the footprint of the staple-forming pockets in an anvil can be limited by the geometry of the anvil. In instances in which the staple-forming pockets are obliquely-oriented relative to a longitudinal axis, the width of the anvil can limit the size and spacing of the obliquely-oriented staple-forming pockets. For example, the width of an intermediate row of staple-forming pockets can define a minimum distance between a first row (e.g. an outer row) on one side of the intermediate row and a second row (e.g. an inner row) on the other side of the intermediate row. Moreover, the rows of staple-forming pockets are confined between an inside edge on the anvil, such as a knife slot, and an outside edge of the anvil.

In various instances, the pockets can be adjacently nested along a staple-forming undersurface of the anvil. For example, an intermediate pocket can be nested between an inner pocket and an outer pocket. The angular orientation of the pockets can vary row-to-row to facilitate the nesting thereof. For example, the staple-forming pockets in an inner row can be oriented at a first angle, the staple-forming pockets in an intermediate row can be oriented at a second angle, and the staple-forming pockets in an outer row can be oriented at a third angle. The first angle, the second angle, and the third angle can be different, which can facilitate the close arrangement of the staple-forming pockets.

Referring again to the previous staple cartridge depicted in FIG. **39** and other previous staple cartridges disclosed in, for example, U.S. Pat. No. 9,801,627, entitled FASTENER CARTRIDGE FOR CREATING FLEXIBLE STAPLE LINES and/or U.S. patent application Ser. No. 14/498,145, filed Sep. 26, 2014, now U.S. Patent Application Publication No. 2016/0089142, entitled METHOD FOR CREATING A FLEXIBLE STAPLE LINE, the varying angles of the staples and the staple cavities in each row can be selected to optimize the nesting of the staple-forming pockets in a complementary anvil. For each such staple cartridge, a complementary anvil can be configured to have a corresponding arrangement of staple-forming pockets. Moreover, the staple-forming pockets in the complementary anvils can be larger than the staple cavities in an effort to facilitate the staple legs land or fall within the staple-forming pockets. For example, the staple legs may be biased outward, such as in the case of V-shaped staples (see FIG. **42**) and the larger footprint of the staple-forming pockets can catch the outwardly-biased staple legs during firing. In various instances, the staple-forming pockets can be 0.005 inches to 0.015 inches longer than the corresponding staple cavities and/or staples. Additionally or alternatively, the staple-receiving cups of each staple-forming pocket can be 0.005 inches to 0.015 inches wider than the corresponding staple cavities. In other instances, the difference in length and/or width can be less than 0.005 inches or more than 0.015 inches.

In instances in which the size of the staples varies within a staple cartridge, the size of the staple-forming pockets can corresponding vary within a complementary anvil. Varying the size of the staple-forming pockets can further facilitate the nesting thereof. For example, in instances in which staple-forming pockets in an intermediate row are shorter than the staple-forming pockets in an inner row or an outer row, the width of the intermediate row of staple-forming pockets can be reduced, which can minimize the requisite spacing between the inner row and the outer row.

The spacing of the staple-forming pockets can also be configured to optimize the nesting thereof. For example, the pockets arranged in an inner row can be longitudinally staggered relative to the pockets arranged in an outer row. Moreover, the pockets in the inner row can partially longitudinally overlap the pockets in the outer row. The pockets in an intermediate row can be longitudinally staggered relative to the pockets in the inner row and the pockets in the outer row. For example, the pockets in the intermediate row can be equidistantly longitudinally offset from the pockets in the outer row and the pockets in the inner row.

EXAMPLES

Example 1

A surgical instrument, comprising a surgical staple cartridge comprising a plurality of staple pockets that are configured to store at least one surgical staple therein. The instrument further comprises an anvil that has a proximal anvil mounting portion that is configured to support the anvil relative to the surgical staple cartridge such that the surgical staple cartridge and the anvil are movable between an open position, a closed position and an over-closed position. The instrument further includes means for stopping tissue that is received between the anvil and the surgical staple cartridge from extending proximally beyond a proximal-most one of the staple pockets. A closure member is configured to axially move between a starting position that corresponds to the open position of the anvil and the staple cartridge, an intermediate position that corresponds to the closed position of the anvil and the staple cartridge and an ending position that corresponds to the over-closed position of the anvil and the staple cartridge. The instrument further comprises means for preventing other tissue from becoming pinched between a distal end of the closure member and the means for stopping when the closure member is in either of the intermediate position and ending position.

Example 2

The surgical instrument of Example 1, wherein the anvil comprises an elongate anvil body that includes a staple-forming undersurface and wherein the means for stopping comprises a first tissue stop that extends downward below the staple-forming undersurface of the elongate anvil body on a portion of one side of the elongate anvil body. The means for stopping also comprises a second tissue stop that extends downward below the staple-forming undersurface of the elongate anvil body on another portion of another side of the elongate anvil body.

Example 3

The surgical instrument of Example 2, wherein each of the first and second tissue stops comprises an upper proximal end portion and a bottom proximal end portion and wherein when the closure member is in the intermediate position, the upper proximal end portion of each of the first and second tissues stop is located a first distance from a distal end of the closure member and the bottom proximal end portion of each of the first and second tissue stops is located a second distance from the distal end of the closure member and wherein the second distance differs from the first distance.

Example 4

The surgical instrument of Example 3, wherein the second distance is greater than the first distance.

Example 5

The surgical instrument of Examples 3 or 4, wherein the upper proximal end portion of each first and second tissue stop comprises an upper chamfered surface.

Example 6

The surgical instrument of Examples 3, 4 or 5, wherein the bottom proximal end portion of each first and second tissue stop comprises a bottom chamfered surface.

Example 7

The surgical instrument of Examples 3, 4, 5 or 6, wherein each first and second tissue stop further comprises a lower proximal end portion that extends between the upper proximal end portion and the bottom proximal end portion.

Example 8

The surgical instrument of Example 7, wherein each lower proximal end portion comprises a lower chamfer surface.

Example 9

The surgical instrument of Example 7, wherein each upper proximal end portion comprises an upper chamfer surface and each lower proximal end portion comprises a lower chamfer surface and each bottom proximal end surface comprises a bottom chamfer surface.

Example 10

The surgical instrument of Examples 7, 8 or 9, wherein the proximal anvil mounting portion comprises a first relieved area that corresponds to each upper proximal end portion and a second relieved area that corresponds to each lower proximal end portion and a third relieved area that corresponds to each bottom proximal end portion.

Example 11

The surgical instrument of Example 3, wherein the upper proximal end portion of each first and second tissue stop is parallel to the distal end of the closure member and the bottom proximal end portion of each first and second tissue stop is not parallel to the distal end of the closure member.

Example 12

The surgical instrument of Example 2, wherein each first and second tissue stop comprises a proximal end portion and wherein the means for preventing comprises a notch in a distal end of the closure member that corresponds to each proximal end portion of the first and second tissue stops.

Example 13

The surgical instrument of Example 12, wherein the proximal end of each first and second tissue stop comprises

an upper proximal end portion and a bottom proximal end portion and wherein the notch is located in confronting relationship with the bottom proximal portion of the corresponding first and second tissue stop when the closure member is in either one of the intermediate and ending positions.

Example 14

The surgical instrument of Example 13, wherein the proximal end of each first and second tissue stop further comprises a lower proximal end portion that extends between the upper proximal end portion and the bottom proximal end portion and wherein the notch is in confronting relationship with at least a portion of the lower proximal end portion and the bottom proximal end portion of the corresponding first and second tissue stops when the closure member is in either one of the intermediate and ending positions.

Example 15

The surgical instrument of Example 13, wherein each bottom proximal end portion terminates in a bottom corner and wherein each notch comprises an arcuate notch that is oriented in confronting relationship such that an apex of the arcuate notch is located directly across from the bottom corner of the corresponding first and second tissue stops when the closure member is in either one of the intermediate and ending positions.

Example 16

The surgical instrument of Examples 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 or 15, wherein the closure member comprises an end effector closure tube.

Example 17

A surgical instrument, comprising a surgical staple cartridge that includes a plurality of staple pockets that are configured to store at least one surgical staple therein. The surgical instrument further comprises an anvil that includes an elongate anvil body that has a staple-forming undersurface. The anvil further includes a proximal anvil mounting portion that is configured to support the anvil for movable travel relative to the surgical staple cartridge between an open position and a closed position. The anvil further includes a first tissue stop that extends downward below the staple-forming undersurface of the elongate anvil body on a portion of one side of the elongate anvil body. The first tissue stop includes a first proximal end. The anvil further comprises a second tissue top that extends downward below the staple-forming undersurface of the elongate anvil body on another portion of another side of the elongate anvil body. The second tissue stop includes a second proximal end. The surgical instrument further comprises a closure member that is configured to axially move between a starting position that corresponds to the open position of the anvil and an ending position that corresponds to the closed position of the anvil and wherein a portion of the first and second proximal ends of each first and second tissue stop is parallel to a distal end of the closure member and wherein another portion of the first and second proximal ends of each first and second tissue stop is not parallel with the distal end of the closure member.

Example 18

The surgical instrument of Example 17, wherein the distal end of the closure member comprises a clearance notch in the distal end that corresponds to the portions of the proximal ends of the first and second tissue stops that are not parallel with the distal end of the closure member.

Example 19

The surgical instrument of Example 18, wherein the clearance notch comprises an arcuate notch in the closure member.

Example 20

A surgical instrument, comprising a channel that is configured to support a surgical staple cartridge therein. An anvil is pivotally supported on the channel for selective pivotal travel between an open position and an over-closed position relative to the channel. The anvil includes an anvil body that has a staple-forming undersurface thereon. At least one tissue stop member extends downward below the staple-forming undersurface from a proximal end portion of the anvil body. The anvil further includes a mounting portion that is proximal to the at least one tissue stop and is configured to movably support the anvil on the channel for selective travel between the open position and the over-closed position. The surgical instrument further comprises a shaft assembly that is operably coupled to the channel. The shaft assembly includes an axially movable closure member that is configured to axially move between a starting position corresponding to the open position of the anvil and an ending position that corresponds to the over-closed position of the anvil. The closure member includes a distal end and at least one recessed area on the distal end corresponding to the tissue stop member so as to establish a predetermined gap therebetween when the closure member is in the ending position to prevent other tissue from being pinched therebetween.

Many of the surgical instrument systems described herein are motivated by an electric motor; however, the surgical instrument systems described herein can be motivated in any suitable manner. In various instances, the surgical instrument systems described herein can be motivated by a manually-operated trigger, for example. In certain instances, the motors disclosed herein may comprise a portion or portions of a robotically controlled system. Moreover, any of the end effectors and/or tool assemblies disclosed herein can be utilized with a robotic surgical instrument system. U.S. patent application Ser. No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Pat. No. 9,072,535, for example, discloses several examples of a robotic surgical instrument system in greater detail.

The surgical instrument systems described herein have been described in connection with the deployment and deformation of staples; however, the embodiments described herein are not so limited. Various embodiments are envisioned which deploy fasteners other than staples, such as clamps or tacks, for example. Moreover, various embodiments are envisioned which utilize any suitable means for sealing tissue. For instance, an end effector in accordance with various embodiments can comprise electrodes configured to heat and seal the tissue. Also, for instance, an end effector in accordance with certain embodiments can apply vibrational energy to seal the tissue.

The entire disclosures of:

U.S. Pat. No. 5,403,312, entitled ELECTROSURGICAL HEMOSTATIC DEVICE, which issued on Apr. 4, 1995;

U.S. Pat. No. 7,000,818, entitled SURGICAL STAPLING INSTRUMENT HAVING SEPARATE DISTINCT CLOSING AND FIRING SYSTEMS, which issued on Feb. 21, 2006;

U.S. Pat. No. 7,422,139, entitled MOTOR-DRIVEN SURGICAL CUTTING AND FASTENING INSTRUMENT WITH TACTILE POSITION FEEDBACK, which issued on Sep. 9, 2008;

U.S. Pat. No. 7,464,849, entitled ELECTRO-MECHANICAL SURGICAL INSTRUMENT WITH CLOSURE SYSTEM AND ANVIL ALIGNMENT COMPONENTS, which issued on Dec. 16, 2008;

U.S. Pat. No. 7,670,334, entitled SURGICAL INSTRUMENT HAVING AN ARTICULATING END EFFECTOR, which issued on Mar. 2, 2010;

U.S. Pat. No. 7,753,245, entitled SURGICAL STAPLING INSTRUMENTS, which issued on Jul. 13, 2010;

U.S. Pat. No. 8,393,514, entitled SELECTIVELY ORIENTABLE IMPLANTABLE FASTENER CARTRIDGE, which issued on Mar. 12, 2013;

U.S. patent application Ser. No. 11/343,803, entitled SURGICAL INSTRUMENT HAVING RECORDING CAPABILITIES; now U.S. Pat. No. 7,845,537;

U.S. patent application Ser. No. 12/031,573, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT HAVING RF ELECTRODES, filed Feb. 14, 2008;

U.S. patent application Ser. No. 12/031,873, entitled END EFFECTORS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed Feb. 15, 2008, now U.S. Pat. No. 7,980,443;

U.S. patent application Ser. No. 12/235,782, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT, now U.S. Pat. No. 8,210,411;

U.S. patent application Ser. No. 12/235,972, entitled MOTORIZED SURGICAL INSTRUMENT, now U.S. Pat. No. 9,050,083.

U.S. patent application Ser. No. 12/249,117, entitled POWERED SURGICAL CUTTING AND STAPLING APPARATUS WITH MANUALLY RETRACTABLE FIRING SYSTEM, now U.S. Pat. No. 8,608,045;

U.S. patent application Ser. No. 12/647,100, entitled MOTOR-DRIVEN SURGICAL CUTTING INSTRUMENT WITH ELECTRIC ACTUATOR DIRECTIONAL CONTROL ASSEMBLY, filed Dec. 24, 2009; now U.S. Pat. No. 8,220,688;

U.S. patent application Ser. No. 12/893,461, entitled STAPLE CARTRIDGE, filed Sep. 29, 2012, now U.S. Pat. No. 8,733,613;

U.S. patent application Ser. No. 13/036,647, entitled SURGICAL STAPLING INSTRUMENT, filed Feb. 28, 2011, now U.S. Pat. No. 8,561,870;

U.S. patent application Ser. No. 13/118,241, entitled SURGICAL STAPLING INSTRUMENTS WITH ROTATABLE STAPLE DEPLOYMENT ARRANGEMENTS, now U.S. Pat. No. 9,072,535;

U.S. patent application Ser. No. 13/524,049, entitled ARTICULATABLE SURGICAL INSTRUMENT COMPRISING A FIRING DRIVE, filed on Jun. 15, 2012; now U.S. Pat. No. 9,101,358;

U.S. patent application Ser. No. 13/800,025, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on Mar. 13, 2013, now U.S. Pat. No. 9,345,481;

U.S. patent application Ser. No. 13/800,067, entitled STAPLE CARTRIDGE TISSUE THICKNESS SENSOR SYSTEM, filed on Mar. 13, 2013, now U.S. Patent Application Publication No. 2014/0263552;

U.S. Patent Application Publication No. 2007/0175955, entitled SURGICAL CUTTING AND FASTENING INSTRUMENT WITH CLOSURE TRIGGER LOCKING MECHANISM, filed Jan. 31, 2006; and

U.S. Patent Application Publication No. 2010/0264194, entitled SURGICAL STAPLING INSTRUMENT WITH AN ARTICULATABLE END EFFECTOR, filed Apr. 22, 2010, now U.S. Pat. No. 8,308,040, are hereby incorporated by reference herein.

Although various devices have been described herein in connection with certain embodiments, modifications and variations to those embodiments may be implemented. Particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. Thus, the particular features, structures, or characteristics illustrated or described in connection with one embodiment may be combined in whole or in part, with the features, structures or characteristics of one ore more other embodiments without limitation. Also, where materials are disclosed for certain components, other materials may be used. Furthermore, according to various embodiments, a single component may be replaced by multiple components, and multiple components may be replaced by a single component, to perform a given function or functions. The foregoing description and following claims are intended to cover all such modification and variations.

The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, a device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps including, but not limited to, the disassembly of the device, followed by cleaning or replacement of particular pieces of the device, and subsequent reassembly of the device. In particular, a reconditioning facility and/or surgical team can disassemble a device and, after cleaning and/or replacing particular parts of the device, the device can be reassembled for subsequent use. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

The devices disclosed herein may be processed before surgery. First, a new or used instrument may be obtained and, when necessary, cleaned. The instrument may then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument may then be placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, and/or high-energy electrons. The radiation may kill bacteria on the instrument and in the container. The sterilized instrument may then be stored in the sterile container. The sealed container may keep the instrument sterile until it is opened in a medical facility. A device may also be sterilized using any other technique known in the art, including but not limited to beta radiation, gamma radiation, ethylene oxide, plasma peroxide, and/or steam.

While this invention has been described as having exemplary designs, the present invention may be further modified within the spirit and scope of the disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles.

What is claimed is:

1. A surgical instrument, comprising:

a surgical staple cartridge comprising a plurality of staple pockets configured to store at least one surgical staple therein;

an anvil comprising a proximal anvil mounting portion configured to support said anvil relative to said surgical staple cartridge such that said surgical staple cartridge and said anvil are movable between an open position, a closed position and an over-closed position;

means for stopping tissue received between said anvil and said surgical staple cartridge from extending proximally beyond a proximal-most one of said plurality of staple pockets;

a closure member configured to axially move between a starting position corresponding to said open position of said anvil and said surgical staple cartridge, an intermediate position corresponding to said closed position of said anvil and said surgical staple cartridge and an ending position corresponding to said over-closed position of said anvil and said surgical staple cartridge; and

means for preventing other tissue from becoming pinched between a distal end of said closure member and said means for stopping when said closure member is in either of said intermediate position and said ending position.

2. The surgical instrument of claim 1, wherein said anvil comprises an elongate anvil body comprising a staple-forming undersurface and wherein said means for stopping comprises:

a first tissue stop extending downward below said staple-forming undersurface of said elongate anvil body on a portion of one side of said elongate anvil body; and

a second tissue stop extending downward below said staple-forming undersurface of said elongate anvil body on another portion of another side of said elongate anvil body.

3. The surgical instrument of claim 2, wherein each of said first and second tissue stops comprises an upper proximal end portion and a bottom proximal end portion and wherein when said closure member is in said intermediate position, said upper proximal end portion of each said first and second tissues stop is located a first distance from a distal end of said closure member and said bottom proximal end portion of each said first and second tissue stops is located a second distance from said distal end of said closure member and wherein said second distance differs from said first distance.

4. The surgical instrument of claim 3, wherein said second distance is greater than said first distance.

5. The surgical instrument of claim 3, wherein said upper proximal end portion of each said first and second tissue stops comprises an upper chamfered surface.

6. The surgical instrument of claim 5, wherein said bottom proximal end portion of each said first and second tissue stops comprises a bottom chamfered surface.

7. The surgical instrument of claim 3, wherein each of said first and second tissue stops further comprises a lower proximal end portion extending between said upper proximal end portion and said bottom proximal end portion.

8. The surgical instrument of claim 7, wherein each said lower proximal end portion comprises a lower chamfer surface.

9. The surgical instrument of claim 7, wherein each said upper proximal end portion comprises an upper chamfer surface and each said lower proximal end portion comprises a lower chamfer surface and each said bottom proximal end portion comprises a bottom chamfer surface.

10. The surgical instrument of claim 7, wherein said proximal anvil mounting portion comprises:

a first relieved area formed therein corresponding to each said upper proximal end portion;

a second relieved area formed therein corresponding to each said lower proximal end portion; and

a third relieved area formed therein corresponding to each said bottom proximal end portion.

11. The surgical instrument of claim 3, wherein said upper proximal end portion of each said first and second tissue stops is parallel to said distal end of said closure member and said bottom proximal end portion of each said first and second tissue stops is not parallel to said distal end of said closure member.

12. The surgical instrument of claim 2, wherein each of said first and second tissue stops comprises a proximal end portion and wherein said means for preventing comprises a notch in a distal end of said closure member corresponding to each said proximal end portion of said first and second tissue stops.

13. The surgical instrument of claim 12, wherein said proximal end of each portion of said first and second tissue stops comprises:

an upper proximal end portion; and

a bottom proximal end portion and wherein said notch is located in confronting relationship with said bottom proximal end portion of said corresponding first and second tissue stop when said closure member is in either one of said intermediate and ending positions.

14. The surgical instrument of claim 13, wherein said proximal end portion of each of said first and second tissue stops further comprises a lower proximal end portion extending between said upper proximal end portion and said bottom proximal end portion and wherein said notch is in confronting relationship with at least a portion of said lower proximal end portion and said bottom proximal end portion of said corresponding first and second tissue stops when said closure member is in either one of said intermediate and ending positions.

15. The surgical instrument of claim 13, wherein each said bottom proximal end portion terminates in a bottom corner and wherein each said notch comprises an arcuate notch oriented in confronting relationship such that an apex of said arcuate notch is located directly across from said bottom corner of said corresponding first and second tissue stops when said closure member is in either one of said intermediate and ending positions.

16. The surgical instrument of claim 1, wherein said closure member comprises an end effector closure tube.

17. A surgical instrument, comprising:

a surgical staple cartridge comprising a plurality of staple pockets configured to store at least one surgical staple therein;

an anvil comprising:

an elongate anvil body comprising a staple-forming undersurface; and

a proximal anvil mounting portion configured to support said anvil for movable travel relative to said surgical staple cartridge between an open position and a closed position;

a first tissue stop extending downward below said staple-forming undersurface of said elongate anvil body on a portion of one side of said elongate anvil body, said first tissue stop comprising a first proximal end; and

a second tissue stop extending downward below said staple-forming undersurface of said elongate anvil body on another portion of another side of said elongate anvil body, said second tissue stop comprising a second proximal end and wherein said surgical instrument further comprises:

a closure member configured to axially move between a starting position corresponding to said open position of said anvil and an ending position corresponding to said closed position of said anvil and wherein a portion of said first and second proximal ends of each said first and second tissue stops is parallel to a distal end of said closure member and wherein another portion of said first and second proximal ends of each said first and second tissue stops is not parallel with said distal end of said closure member.

18. The surgical instrument of claim **17**, wherein said distal end of said closure member comprises a clearance notch in said distal end corresponding to said portions of said proximal ends of said first and second tissue stops that are not parallel with said distal end of said closure member.

19. The surgical instrument of claim **18**, wherein said clearance notch comprises an arcuate notch in said closure member.

20. A surgical instrument, comprising:

a channel configured to support a surgical staple cartridge therein;

an anvil pivotally supported on said channel for selective pivotal travel between an open position and an over-closed position relative to said channel, said anvil comprising:

an anvil body;

a staple-forming undersurface on said anvil body;

at least one tissue stop member extending downward below said staple-forming undersurface from a proximal end portion of said anvil body; and

a mounting portion proximal to said at least one tissue stop member and configured to movably support said anvil on said channel for selective travel between said open position and said over-closed position and wherein said surgical instrument further comprises:

a shaft assembly operably coupled to said channel and comprising an axially movable closure member configured to axially move between a starting position corresponding to said open position of said anvil and an ending position corresponding to said over-closed position of said anvil, said axially movable closure member comprising:

a distal end; and

at least one recessed area on said distal end corresponding to said at one tissue stop member so as to establish a predetermined gap therebetween when said axially movable closure member is in said ending position to prevent other tissue from being pinched therebetween.

* * * * *